2018 SchweserNotes™ Part II

FRM® Exam Prep

Risk Management and Investment Management; Current Issues in Financial Markets

eBook 4

KAPLAN SCHWESER

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FRM® Exam Part II

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FRM Part II Book 4: Risk Management and Investment Management; Current Issues in Financial Markets

FRM 2018 PART II BOOK 4: RISK MANAGEMENT AND INVESTMENT MANAGEMENT; CURRENT ISSUES IN FINANCIAL MARKETS

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Reading Assignments and Learning Objectives

The following material is a review of the Risk Management and Investment Management, and Current Issues in Financial Markets principles designed to address the learning objectives set forth by the Global Association of Risk Professionals.

Reading Assignments

Risk Management and Investment Management

Andrew Ang, *Asset Management: A Systematic Approach to Factor Investing* (New York, NY: Oxford University Press, 2014).

62. "Factor Theory," Chapter 6 (page 1)

63. "Factors," Chapter 7 (page 15)

64. "Alpha (and the Low-Risk Anomaly)," Chapter 10 (page 31)

65. "Illiquid Assets," Chapter 13 (page 47)

Richard Grinold and Ronald Kahn, *Active Portfolio Management: A Quantitative Approach for Producing Superior Returns and Controlling Risk, 2nd Edition* (New York, NY: McGraw-Hill, 2000).

66. "Portfolio Construction," Chapter 14 (page 61)

Philippe Jorion, *Value-at-Risk: The New Benchmark for Managing Financial Risk, 3rd Edition* (New York, NY: McGraw-Hill, 2007).

67. "Portfolio Risk: Analytical Methods," Chapter 7 (page 73)

68. "VaR and Risk Budgeting in Investment Management," Chapter 17 (page 90)

Robert Litterman and the Quantitative Resources Group, *Modern Investment Management: An Equilibrium Approach* (Hoboken, NJ: John Wiley & Sons, 2003).

69. "Risk Monitoring and Performance Measurement," Chapter 17 (page 106)

Zvi Bodie, Alex Kane, and Alan J. Marcus, *Investments, 10th Edition* (New York, NY: McGraw-Hill, 2013).

70. "Portfolio Performance Evaluation," Chapter 24 (page 117)

Learning Objectives

62. Factor Theory

After completing this reading, you should be able to:

1. Provide examples of factors that impact asset prices, and explain the theory of factor risk premiums. (page 1)
2. Describe the capital asset pricing model (CAPM) including its assumptions, and explain how factor risk is addressed in the CAPM. (page 2)
3. Explain implications of using the CAPM to value assets, including equilibrium and optimal holdings, exposure to factor risk, its treatment of diversification benefits, and shortcomings of the CAPM. (page 2)
4. Describe multifactor models, and compare and contrast multifactor models to the CAPM. (page 6)
5. Explain how stochastic discount factors are created and apply them in the valuation of assets. (page 6)
6. Describe efficient market theory and explain how markets can be inefficient. (page 8)

63. Factors

After completing this reading, you should be able to:

1. Describe the process of value investing, and explain reasons why a value premium may exist. (page 15)
2. Explain how different macroeconomic risk factors, including economic growth, inflation, and volatility affect risk premiums and asset returns. (page 16)
3. Assess methods of mitigating volatility risk in a portfolio, and describe challenges that arise when managing volatility risk. (page 19)
4. Explain how dynamic risk factors can be used in a multifactor model of asset returns, using the Fama-French model as an example. (page 20)
5. Compare value and momentum investment strategies, including their risk and return profiles. (page 22)

64. Alpha (and the Low-Risk Anomaly)

After completing this reading, you should be able to:

1. Describe and evaluate the low-risk anomaly of asset returns. (page 31)
2. Define and calculate alpha, tracking error, the information ratio, and the Sharpe ratio. (page 31)
3. Explain the impact of benchmark choice on alpha, and describe characteristics of an effective benchmark to measure alpha. (page 33)
4. Describe Grinold's fundamental law of active management, including its assumptions and limitations, and calculate the information ratio using this law. (page 34)
5. Apply a factor regression to construct a benchmark with multiple factors, measure a portfolio's sensitivity to those factors, and measure alpha against that benchmark. (page 35)
6. Explain how to measure time-varying factor exposures and their use in style analysis. (page 38)
7. Describe issues that arise when measuring alphas for nonlinear strategies. (page 39)
8. Compare the volatility anomaly and beta anomaly, and analyze evidence of each anomaly. (page 40)
9. Describe potential explanations for the risk anomaly. (page 41)

65. Illiquid Assets

After completing this reading, you should be able to:

1. Evaluate the characteristics of illiquid markets. (page 47)
2. Examine the relationship between market imperfections and illiquidity. (page 48)
3. Assess the impact of biases on reported returns for illiquid assets. (page 49)
4. Describe the unsmoothing of returns and its properties. (page 49)
5. Compare illiquidity risk premiums across and within asset categories. (page 51)
6. Evaluate portfolio choice decisions on the inclusion of illiquid assets. (page 55)

66. Portfolio Construction

After completing this reading, you should be able to:

1. Distinguish among the inputs to the portfolio construction process. (page 61)
2. Evaluate the methods and motivation for refining alphas in the implementation process. (page 61)
3. Describe neutralization and methods for refining alphas to be neutral. (page 62)
4. Describe the implications of transaction costs on portfolio construction. (page 63)
5. Assess the impact of practical issues in portfolio construction, such as determination of risk aversion, incorporation of specific risk aversion, and proper alpha coverage. (page 64)
6. Describe portfolio revisions and rebalancing, and evaluate the tradeoffs between alpha, risk, transaction costs, and time horizon. (page 65)
7. Determine the optimal no-trade region for rebalancing with transaction costs. (page 65)
8. Evaluate the strengths and weaknesses of the following portfolio construction techniques. screens, stratification, linear programming, and quadratic programming. (page 66)
9. Describe dispersion, explain its causes, and describe methods for controlling forms of dispersion. (page 68)

67. Portfolio Risk: Analytical Methods

After completing this reading, you should be able to:

1. Define, calculate, and distinguish between the following portfolio VaR measures. individual VaR, incremental VaR, marginal VaR, component VaR, undiversified portfolio VaR, and diversified portfolio VaR. (page 73)
2. Explain the role of correlation on portfolio risk. (page 74)
3. Describe the challenges associated with VaR measurement as portfolio size increases. (page 78)
4. Apply the concept of marginal VaR to guide decisions about portfolio VaR. (page 82)
5. Explain the risk-minimizing position and the risk and return-optimizing position of a portfolio. (page 82)
6. Explain the difference between risk management and portfolio management, and describe how to use marginal VaR in portfolio management. (page 83)

68. VaR and Risk Budgeting in Investment Management

After completing this reading, you should be able to:

1. Define risk budgeting. (page 90)
2. Describe the impact of horizon, turnover, and leverage on the risk management process in the investment management industry. (page 90)
3. Describe the investment process of large investors such as pension funds. (page 91)

4. Describe the risk management challenges associated with investments in hedge funds. (page 92)
5. Distinguish among the following types of risk: absolute risk, relative risk, policy-mix risk, active management risk, funding risk, and sponsor risk. (page 92)
6. Apply VaR to check compliance, monitor risk budgets, and reverse engineer sources of risk. (page 95)
7. Explain how VaR can be used in the investment process and the development of investment guidelines. (page 97)
8. Describe the risk budgeting process and calculate risk budgets across asset classes and active managers. (page 98)

69. Risk Monitoring and Performance Measurement

After completing this reading, you should be able to:

1. Define, compare, and contrast VaR and tracking error as risk measures. (page 106)
2. Describe risk planning, including its objectives, effects, and the participants in its development. (page 107)
3. Describe risk budgeting and the role of quantitative methods in risk budgeting. (page 108)
4. Describe risk monitoring and its role in an internal control environment. (page 108)
5. Identify sources of risk consciousness within an organization. (page 108)
6. Describe the objectives and actions of a risk management unit in an investment management firm. (page 109)
7. Describe how risk monitoring can confirm that investment activities are consistent with expectations. (page 110)
8. Explain the importance of liquidity considerations for a portfolio. (page 110)
9. Describe the use of alpha, benchmark, and peer group as inputs in performance measurement tools. (page 112)
10. Describe the objectives of performance measurement. (page 111)

70. Portfolio Performance Evaluation

After completing this reading, you should be able to:

1. Differentiate between time-weighted and dollar-weighted returns of a portfolio and describe their appropriate uses. (page 117)
2. Describe and distinguish between risk-adjusted performance measures, such as Sharpe's measure, Treynor's measure, Jensen's measure (Jensen's alpha), and information ratio. (page 120)
3. Describe the uses for the Modigliani-squared and Treynor's measure in comparing two portfolios, and the graphical representation of these measures. (page 120)
4. Determine the statistical significance of a performance measure using standard error and the t-statistic. (page 127)
5. Explain the difficulties in measuring the performance of hedge funds. (page 128)
6. Explain how changes in portfolio risk levels can affect the use of the Sharpe ratio to measure performance. (page 128)
7. Describe techniques to measure the market timing ability of fund managers with a regression and with a call option model, and compute return due to market timing. (page 129)
8. Describe style analysis. (page 131)
9. Describe and apply performance attribution procedures, including the asset allocation decision, sector and security selection decision, and the aggregate contribution. (page 131)

71. Hedge Funds

After completing this reading, you should be able to:

1. Describe the characteristics of hedge funds and the hedge fund industry, and compare hedge funds with mutual funds. (page 139)
2. Explain biases that are commonly found in databases of hedge funds. (page 139)
3. Explain the evolution of the hedge fund industry and describe landmark events that precipitated major changes in the development of the industry. (page 139)
4. Evaluate the role of investors in shaping the hedge fund industry. (page 139)
5. Explain the relationship between risk and alpha in hedge funds. (page 140)
6. Compare and contrast the different hedge fund strategies, describe their return characteristics, and describe the inherent risks of each strategy. (page 141)
7. Describe the historical portfolio construction and performance trend of hedge funds compared to equity indices. (page 144)
8. Describe market events that resulted in a convergence of risk factors for different hedge fund strategies, and explain the impact of such a convergence on portfolio diversification strategies. (page 145)
9. Describe the problem of risk sharing asymmetry between principals and agents in the hedge fund industry. (page 145)
10. Explain the impact of institutional investors on the hedge fund industry and assess reasons for the growing concentration of assets under management (AUM) in the industry. (page 146)

72. Performing Due Diligence on Specific Managers and Funds

After completing this reading, you should be able to:

1. Identify reasons for the failures of funds in the past. (page 151)
2. Explain elements of the due diligence process used to assess investment managers. (page 152)
3. Identify themes and questions investors can consider when evaluating a manager. (page 153)
4. Describe criteria that can be evaluated in assessing a fund's risk management process. (page 155)
5. Explain how due diligence can be performed on a fund's operational environment. (page 156)
6. Explain how a fund's business model risk and its fraud risk can be assessed. (page 158)
7. Describe elements that can be included as part of a due diligence questionnaire. (page 159)

73. The New Era of Expected Credit Loss Provisioning

After completing this reading, you should be able to:

1. Describe the reasons to provision for expected credit losses. (page 165)
2. Compare and contrast the key aspects of the IASB (IFRS 9) and FASB (CECL) standards. (page 166)
3. Assess the progress banks have made in the implementation of the standards. (page 167)
4. Examine the impact on the financial system posed by the standards. (page 168)

74. Big Data: New Tricks for Econometrics

After completing this reading, you should be able to:

1. Describe the issues unique to big datasets. (page 172)
2. Explain and assess different tools and techniques for manipulating and analyzing big data. (page 173)
3. Examine the areas for collaboration between econometrics and machine learning. (page 177)

75. Machine Learning: A Revolution in Risk Management and Compliance?

After completing this reading, you should be able to:

1. Describe the process of machine learning and compare machine learning approaches. (page 182)
2. Describe the application of machine learning approaches within the financial services sector and the types of problems to which they can be applied. (page 184)
3. Analyze the application of machine learning in three use cases:)
   - Credit risk and revenue modeling)
   - Fraud)
   - Surveillance of conduct and market abuse in trading (page 184)

76. Central Clearing and Risk Transformation

After completing this reading, you should be able to:

1. Examine how the clearing of over-the-counter transactions through central counterparties has affected risks in the financial system. (page 191)
2. Assess whether central clearing has enhanced financial stability and reduced systemic risk. (page 192)
3. Describe the transformation of counterparty risk into liquidity risk. (page 193)
4. Explain how liquidity of clearing members and liquidity resources of CCPs affect risk management and financial stability. (page 193)
5. Compare and assess methods a CCP can use to help recover capital when a member defaults or when a liquidity crisis occurs. (page 196)

77. The Bank/Capital Markets Nexus Goes Global

After completing this reading, you should be able to:

1. Describe the links between banks and capital markets. (page 201)
2. Explain the effects of forced deleveraging and the failure of covered interest rate parity. (page 201)
3. Discuss the US dollar's role as the measure of the appetite for leverage. (page 203)
4. Describe the implications of a stronger US dollar on financial stability and the real economy. (page 204)

78. FinTech Credit: Market Structure, Business Models and Financial Stability Implications

After completing this reading, you should be able to:

1. Describe how FinTech credit markets are likely to develop and how they will affect the nature of credit provision and the traditional banking sector. (page 209)
2. Analyze the functioning of FinTech credit markets and activities, and assess the potential microfinancial benefits and risks of these activities. (page 211)
3. Examine the implications for financial stability in the event that FinTech credit grows to account for a significant share of overall credit. (page 219)

79. The Gordon Gekko Effect: The Role of Culture in the Financial Industry

After completing this reading, you should be able to:

1. Explain how different factors can influence the culture of a corporation in both positive and negative ways. (page 227)
2. Examine the role of culture in the context of financial risk management. (page 230)
3. Describe the framework for analyzing culture in the context of financial practices and institutions. (page 231)
4. Analyze the importance of culture and a framework that can be used to change or improve a corporate culture. (page 234)

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Factor Theory

Topic 62

Exam Focus

In this topic, we introduce factor theory and factor risk. A key point is that it is not the exposure to an asset that is rewarded, but the exposure to the underlying factors. The risk of these factors is being rewarded with risk premiums. Several factor theories are introduced, including the capital asset pricing model (CAPM) and multifactor models. For the exam, understand the key assumptions of the CAPM while recognizing the model's limitations in a real-world setting, and be able to contrast the CAPM with the assumptions of multifactor models. Through multifactor models, we introduce the concept of a stochastic discount factor, which is a random variable used in pricing an asset. Finally, be familiar with the efficient market hypothesis, since it identifies areas of market inefficiencies that can be exploited through active management.

Factors That Impact Asset Prices

LO 62.1: Provide examples of factors that impact asset prices, and explain the theory of factor risk premiums.

In the context of factor investing, it is easiest to think of assets as bundles of **factor risks**, where exposure to the different factor risks earns risk premiums. The underlying **factors** may include the market (which is a tradable investment factor), interest rates, or investing styles (including value/growth, low volatility, or momentum). Factors may also be classified as fundamental macroeconomic factors, such as inflation and economic growth.

Factor theory is based on an analysis of factor risks. Factor risks represent exposures to *bad times*, where these exposures are rewarded with risk premiums. Factor theory is based on three primary principles:

1. *Factors are important, not assets*. It is not exposure to the specific asset that matters, rather the exposure to the underlying risk factors. As a result, investors must look through assets and understand the underlying factor risks.

2. *Assets represent bundles of factors*. Assets typically represent bundles of risk factors, although some assets, like equities and government bonds, can be thought of as factors themselves. Other assets, including corporate bonds, private equity, and hedge funds, contain many factors, such as equity risk, interest rate risk, volatility risk, and default risk. Assets' risk premiums reflect these risk factors.

3. *Investors have differing optimal risk exposures*. Investors each have different optimal exposures to risk factors. One of the important factors is volatility. Higher volatility results in higher asset risks during bad times. One important recent example of bad times was the 2007–2009 financial crisis. In return for bearing factor risks, investors require compensation through a risk premium (e.g., a volatility premium for volatility risk) during normal times. Economic growth represents another factor to which investors want different exposures.

Bad times could represent economic bad times, including high inflation and low economic growth. They could also represent bad times for investing, including poorly performing investments or markets. Factors are all unique and each represents exposure to a different set of bad times.

Capital Asset Pricing Model

LO 62.2: Describe the capital asset pricing model (CAPM) including its assumptions, and explain how factor risk is addressed in the CAPM.

The **capital asset pricing model** (CAPM) describes how an asset behaves not in isolation, but in relation to other assets and to the market. The CAPM views not the asset's own volatility as the relevant measure, but its covariance with the market portfolio, as measured by the asset's *beta*.

The CAPM assumes that the only relevant factor is the market portfolio, and risk premiums are determined solely by beta. As mentioned, risk premiums are important because they compensate investors for losses during bad times. Risk here is determined by the assets' movements relative to each other, and not by the assets in isolation.

LO 62.3: Explain implications of using the CAPM to value assets, including equilibrium and optimal holdings, exposure to factor risk, its treatment of diversification benefits, and shortcomings of the CAPM.

Implications of Using the CAPM

The CAPM holds six important lessons.

Lesson 1: Hold the factor, not the individual asset.

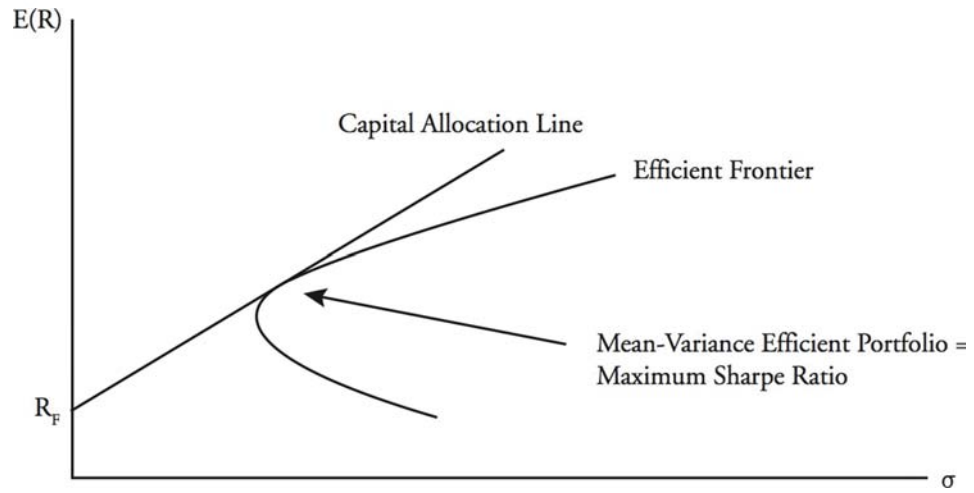
In a CAPM world, stocks are held in proportion to their market capitalization, where the sole factor is the market portfolio. The market portfolio can be constructed by holding many assets, which helps diversify away *idiosyncratic (firm-specific) risk*, leaving only *systematic (market) risk*. Individual stocks have risk premiums, which compensate investors for being exposed to the market factor. Market risk affects all investors exposed to the market portfolio.

According to the CAPM, investors do not wish to hold assets in isolation, because diversification improves the risk-return profile of a portfolio. The concept is simple: diversification helps ensure that bad returns from one asset will be offset by the returns of

other assets that perform well. This also improves Sharpe ratios (i.e., risk premium divided by total risk). Investors continue to diversify until they are left with the market portfolio, which represents the optimal diversified portfolio.

Mean-variance efficient portfolio. Portfolio diversification and Sharpe ratios can be graphically represented by the mean-variance **efficient frontier**. When investors hold portfolios that combine the risky asset and the risk-free asset, the various risk-return combinations are represented by the **capital allocation line** (CAL). The risky asset in this case is the *mean-variance efficient* (MVE) *market portfolio*, which is efficient because it represents the maximum Sharpe ratio given investors' preferences. The specific combination of the risk-free asset and MVE portfolio depends on investors' risk aversions.

Figure 1: Capital Allocation Line



Equilibrium. In equilibrium, demand for an asset equals supply, and since under the CAPM all investors hold the risky MVE market portfolio, the market is the factor. For equilibrium to happen, someone must hold the MVE portfolio as the risky asset. If no investor held the risky asset, the risky asset must be overpriced, and its expected return must be too low. This situation cannot represent an equilibrium state. Since under CAPM the expected payoff of an asset remains constant, the asset's expected return must increase as its price falls. In equilibrium, the risk factor is the market, and it has a risk premium. The market factor is a function of investor risk aversions and utilities, and risk premiums will not disappear since investors cannot use arbitrage to remove systematic risk.

Lesson 2: Investors have their own optimal factor risk exposures.

Every investor holds the same risky MVE market portfolio, but the proportion in which they hold it differs. Investors hold different combinations of the risk-free asset and the risky portfolio, representing various positions along the CAL.

Lesson 3: The average investor is fully invested in the market.

An investor with an average risk aversion would hold 100% of the risky MVE market portfolio, which represents the tangency point of the MVE frontier and the CAL. The average investor's risk aversion is, therefore, the risk aversion of the market.

Lesson 4: Exposure to factor risk must be rewarded.

When all investors invest in the same risky MVE portfolio, the CAL for an investor is called the **capital market line** (CML) in equilibrium. The risk premium of the CML depends on an investor's risk aversion and the volatility of the market portfolio:

$$E(R_M) - R_F = \bar{\gamma} \times \sigma_M^2$$

where $E(R_M) - R_F$ is the market risk premium, $\bar{\gamma}$ is the average investor's risk aversion, and σ_M^2 is the market portfolio's variance. During volatile market times (e.g., the 2007–2009 financial crisis), equity prices typically fall and expected returns increase. In the CAPM world, the risk premium is proportional to the market variance. Because market variance removes all idiosyncratic risk, the remaining systematic risk should be rewarded through the risk premium. When the average investor's risk aversion increases, the market risk premium should also increase.

Lesson 5: Risk is measured as beta exposure.

An individual asset's risk is measured as factor exposure to the asset, and higher factor exposures to the asset indicate higher expected returns (assuming the risk premium is positive). The risk premium of an individual asset is derived under the CAPM formula using beta pricing to construct the **security market line** (SML). The formula states that:

$$E(R_i) - R_F = \frac{\text{cov}(R_i, R_M)}{\text{var}(R_M)} \times [E(R_M) - R_F] = \beta_i \times [E(R_M) - R_F]$$

where R_i is the individual stock's return, R_F is the risk-free rate, and **beta** is a function of the market variance and the asset's co-movement with the market: [$\beta_i = \text{cov}(R_i, R_M) / \text{var}(R_M)$]. Higher co-movements denote higher betas, which correspond to higher risk premiums. Whereas previously we looked at systematic risk and diversification, beta looks at idiosyncratic risk and the lack of diversification.

Higher betas imply lower diversification benefits. Investors tend to find high betas (high sensitivities to market returns) unattractive, and, therefore, want to be compensated with higher expected returns. On the other hand, low beta assets are valuable because they do comparatively well when markets perform poorly, offering significant diversification benefits. During the financial crisis, certain assets (safe havens like gold and government bonds) became so attractive that they had negative expected returns. This meant investors actually paid to hold these assets!

Lesson 6: Valuable assets have low risk premiums.

The CAPM risk premium represents the reward investors receive for holding the asset in bad times. Since the market portfolio is the risk factor, bad times indicate low market returns. Assets that have losses during periods of low market returns have high betas, which

indicates they are risky and, therefore, should have high risk premiums. Low beta assets have positive payoffs when the market performs poorly, making them valuable to investors. As a result, investors do not require high risk premiums to hold these assets.

Shortcomings of the CAPM

The CAPM makes several simplifying assumptions that are necessary to make the model work; however, many of these assumptions are considered overly simplistic or not reflective of the real world. The assumptions of the CAPM break down especially in illiquid, inefficient markets where information may be costly and not available to all investors. We look at seven of these assumptions:

1. *Investors only have financial wealth*. Investors have unique income streams and liabilities. Liabilities are often denominated in real terms, and income streams are risky because incomes decline during periods of low economic growth. As a result, both inflation and income growth are important factors. In general, investors have many factors that contribute to wealth, including human capital (or labor income risk).

2. *Investors have mean-variance utility*. Mean-variance utility assumes a symmetric treatment of risk. In reality, investors have an asymmetric view of risk, disliking losses more than they like gains, which deviates from the CAPM assumptions. Therefore, in the real world, stocks exhibit different levels of downside risks. Those with higher downside risks should offer higher returns.

3. *Investors have a single period investment horizon*. While not a main assumption of the CAPM, a single period restriction does not hold in the real world. In the CAPM, all investors hold the market portfolio, which does not require rebalancing. However, the optimal strategy for long-term investors is to rebalance, which is a multi-period strategy.

4. *Investors have homogeneous (identical) expectations*. The assumption that all investors share the same expectations is not realistic in the real world, because investors have heterogeneous (differing) expectations. This can produce significant departures from the CAPM.

5. *Markets are frictionless (no taxes or transaction costs)*. We all know that taxes and transaction costs affect investor returns; therefore, the CAPM assumption of frictionless markets does not hold in the real world. For illiquid securities, transaction costs can be very high, further heightening the deviations from the CAPM. In addition, investors have heterogeneous beliefs, but they may not be able to fully act on differing expectations if there are trading restrictions (e.g., a prohibition on short selling). When this happens, stock prices reflect only the expectations of those who believe stock prices will rise, causing asymmetries in the market. This is a deviation from the CAPM.

6. *All investors are price takers*. In the real world, investors are often price setters and not price takers. Large (institutional) investors frequently trade on special knowledge, and large trades will often move the market.

7. *Information is free and available to everyone*. In reality, information itself can be a factor. Information is often costly and unavailable to certain investors, which is a deviation from the CAPM.

Multifactor Models

LO 62.4: Describe multifactor models, and compare and contrast multifactor models to the CAPM.

As mentioned, the CAPM is a single-factor model that looks at the market as the only factor and defines bad times as low returns to the market portfolio. By contrast, **multifactor models** incorporate other risk factors, including low economic growth, low GDP growth, or low consumption. One of the earliest multifactor models was **arbitrage pricing theory** (APT), which describes expected returns as a linear function of exposures to common (i.e., macroeconomic) risk factors.

The lessons from multifactor models are similar to the lessons from the CAPM:

1. *Diversification is beneficial.* In the CAPM, the market removes (diversifies away) idiosyncratic risk. In multifactor models, it is the tradable version of a factor that removes this risk.

2. *Investors have optimal exposures.* Each investor has an optimal exposure to the market portfolio (in the CAPM) or to factor risks (in multifactor models).

3. *The average investor holds the market portfolio.* This is true under both the CAPM and multifactor models.

4. *Exposure to factor risk must be rewarded.* In the CAPM, the market factor is priced in equilibrium. In multifactor models, each factor has a risk premium, assuming no arbitrage or equilibrium.

5. *Risk is measured by a beta factor.* In the CAPM, an asset's risk is measured by its beta. In multifactor models, an asset's risk is measured by its factor exposures (i.e., factor betas).

6. *Valuable assets have low risk premiums.* Assets that have a positive payoff in bad times are attractive, and, therefore, have low risk premiums. In the CAPM, bad times are explicitly defined as low market returns.

Pricing Kernels

LO 62.5: Explain how stochastic discount factors are created and apply them in the valuation of assets.

Multifactor models define bad times over multiple factors. They use the concept of a **pricing kernel**, also known as the **stochastic discount factor** (SDF), which represents a random variable used in pricing an asset. The SDF represents an index of bad times, where the bad times are indexed by a multitude of different factors and states. The SDF is denoted as m in the multifactor model, where m is a single variable that captures all bad times for any given a and b constants:

$$m = a + b \times R_m$$

The CAPM is a special case of this model, where *m* moves linearly with the market return. However, modeling returns as linear is a shortcoming of the CAPM, which can be improved upon by using the pricing kernel which allows for the assumption of nonlinearity.

We can expand this model to include various factor exposures (f_1, f_2, etc.) where SDF depends on a vector of these factors, where all the *k* factors represent different bad times:

$$m = a + b_1 f_1 + b_2 f_2 + \ldots + b_k f_k$$

With multifactor pricing kernels, bad times can be defined as periods when an additional $1 income becomes very valuable. Looking at bad times this way interprets SDF as a *marginal utility*. Periods of high marginal utility could arise from the loss of a job (resulting in low income, where the value of an extra dollar is high), low GDP growth, low consumption (resulting in current consumption below past consumption), or generally low economic growth.

Pricing Kernels vs. Discount Rate Models

In a traditional discount rate model, the price of an asset is determined by discounting its future cash flows at the appropriate discount rate:

$$P_i = E\left[\frac{\text{payoff}_i}{1 + E(R_i)}\right]$$

The discount rate is determined through the CAPM as:

$$E(R_i) = R_F + \beta_i \times \left[E(R_M) - R_F\right]$$

The SDF model can also be used to predict an asset's price, where we use the SDF as the relevant factor:

$$P_i = E\left[m \times \text{payoff}_i\right]$$

This equation helps explain the name "stochastic discount factor," since the payoffs are discounted using *m* as the relevant factor. The SDF is called a "pricing kernel," using the term kernel from statistics where we estimate *m* using the kernel estimator. Because the kernel is used to derive asset pricing, it is called a pricing kernel.

If we divide both sides of the equation by the asset's current price, P_i, the equation gives us a constant payoff formula, which we can then use to derive the risk-free asset:

$$\frac{P_i}{P_i} = E\left[m \times \frac{payoff_i}{P_i}\right]$$

$$1 = E\left[m \times (1 + R_i)\right]$$

$$\frac{1}{1 + R_F} = E\left[m \times 1\right], \text{ when payoffs are constant}$$

We can also model an asset's risk premium similar to the CAPM, where [$\beta_{i,m}$ = cov(R_i, m) / var(m)]:

$$E(R_i) - R_F = \frac{cov(R_i, m)}{var(m)} \times \left(-\frac{var(m)}{E(m)}\right) = \beta_{i,m} \times \lambda_m$$

Beta is multiplied by the price of the "bad times" risk, determined as:

$$\lambda_m = -\frac{var(m)}{E(m)}$$

This equation represents the inverse of factor risk (denoted by the negative sign). In short, assets that have a positive payoff in bad times are valuable to hold, leading to high prices and low expected returns.

The equation for expected return can also be modeled as having exposure to the risk-free rate and multiple betas in the SDF model. Each beta represents a different macroeconomic factor, such as inflation, economic growth, the market portfolio, or investment strategy:

$$E(R_i) = R_F + \beta_{i,1} \times E(f_1) + \beta_{i,2} \times E(f_2) + \ldots + \beta_{i,k} \times E(f_k)$$

Efficient Market Theory

LO 62.6: Describe efficient market theory and explain how markets can be inefficient.

The APT was one of the earliest forms of the **efficient market theory**. The APT is a multifactor model where market participants—including active managers and arbitrageurs—move an asset's expected return toward a value that represents an equilibrium risk-return tradeoff. The APT uses systematic factors that cannot be removed through arbitrage. As a result, investors demand to be compensated for this risk in the form of a risk premium.

Another efficient market theory was developed by Sanford Grossman and Joseph Stiglitz (1980).[1] In their theory, markets are near-efficient and information is costless. Market efficiency is in part caused by active managers searching for areas of inefficiency, making markets more efficient in the process. We can expect to find these areas of inefficiency in illiquid market segments where information does not move freely and where these inefficiencies make it difficult to earn large profits. Note, however, that the assumption of costless information creates a circular argument: if there is no cost to information and prices already reflect all information, there wouldn't be a need to collect information. However, if no one collects information, then it cannot be fully reflected in asset prices.

Market efficiency is also described in the **efficient market hypothesis** (EMH). The EMH implies that speculative trading is costly, and active managers cannot generally beat the market. The average investor, who holds the market portfolio, can beat the market simply by saving on transaction costs. Even if markets cannot be perfectly efficient, the EMH is still useful because it can help investors identify areas of market inefficiency that can be exploited through active management.

The EMH has been refined to improve upon the CAPM's shortcomings by allowing for imperfect information and various costs, including transaction, financing, and agency costs. Behavioral biases also represent inefficiencies, which have similar effects as frictions. Behavioral biases can be described either through a rational or behavioral explanation approach.

Under the *rational explanation* approach, losses during bad times are compensated by high returns. It is important to clearly define what bad times constitutes, and whether these bad times are actually bad for investors. For example, an investor who shorted the market would benefit, rather than incur losses, in a "bad times" scenario.

Under the *behavioral explanation* approach, it is agents' reactions (under/overreaction) to news that generates high returns. Perfectly rational investors are not prone to these biases, and they provide their own capital to take advantage of mispricing caused by biases. However, the markets may have barriers to the entry of capital that make it difficult to take advantage of mispricings, including structural barriers (e.g., certain investors are unable to take advantage of an opportunity) and regulatory barriers (e.g., minimum credit rating requirement of asset holdings). Structural barriers allow for behavioral biases to persist for a long time.

Ultimately, it is not the type of bias that matters, but whether the investor is different from the average investor who is subject to both rational and behavioral constraints, and whether return opportunities are expected to persist.

1. Sanford J. Grossman and Joseph E. Stiglitz, "On the Impossibility of Efficient Markets," *American Economic Review* 70 (1980): 393–498.

Key Concepts

LO 62.1

Exposure to different factor risks earns risk premiums. Underlying factors may include the market, interest rates, investing styles, inflation, and economic growth. Factor risks represent exposures to bad times, and this exposure must be compensated for with risk premiums. There are three important principles of factor risk:

1. It is not exposure to the specific asset that matters, rather the exposure to the underlying risk factors.
2. Assets represent bundles of factors, and assets' risk premiums reflect these risk factors.
3. Investors each have different optimal exposures to risk factors, including volatility.

LO 62.2

The capital asset pricing model (CAPM) is a single-factor model that describes how an asset behaves in relation to other assets and to the market. The CAPM incorporates an asset's covariance with the market portfolio, measured by the asset's beta. In the CAPM world, the only relevant factor is the market portfolio, and risk premiums are determined solely by beta.

LO 62.3

The CAPM has six important lessons:

1. Hold the factor, not the individual asset.
2. Investors have their own optimal factor risk exposures.
3. The average investor is fully invested in the market.
4. Exposure to factor risk must be rewarded.
5. Risk is measured as beta exposure.
6. Valuable assets have low risk premiums.

The CAPM has six main shortcomings (i.e., unrealistic simplifying assumptions):

1. Investors only have financial wealth.
2. Investors have mean-variance utility.
3. Investors have a single period investment horizon.
4. Investors have homogeneous (identical) expectations.

5. Markets are frictionless (no taxes or transaction costs).

6. All investors are price takers.

LO 62.4

There are six lessons from the multifactor models:

1. Diversification is beneficial.

2. Investors have optimal exposures, to factor risks in multifactor models.

3. The average investor holds the market portfolio.

4. Exposure to factor risks must be rewarded through risk premiums.

5. Risk is measured by factor betas.

6. Valuable assets have low risk premiums.

LO 62.5

Multifactor models define bad times over multiple factors using a pricing kernel, also known as the stochastic discount factor (SDF). The SDF represents an index of bad times. The SDF is denoted as *m* in the multifactor model, representing a single variable that captures all bad times for any given *a* and *b* constants:

$$m = a + b \times R_m$$

The SDF model can also be set up using multiple factor exposures where factors represent different bad times.

The SDF model can be used to predict an asset's price, where SDF is the relevant factor *m*:

$$P_i = E[m \times payoff_i]$$

The asset's risk premium can be modeled using beta.

The risk premium equation can be set up using multiple factor exposures where factors represent different macroeconomic factors, including inflation, economic growth, the market portfolio, or investment strategy.

LO 62.6

Arbitrage pricing theory (APT) uses systematic factors that cannot be removed through arbitrage, and for which investors must be compensated for through risk premiums.

Another efficient market theory developed suggests that markets are near-efficient and information is costless. Active managers search for areas of inefficiency in illiquid market segments, making markets more efficient in the process.

The efficient market hypothesis (EMH) states that speculative trading is expensive, and active managers cannot beat the market on average. The EMH is useful because it helps investors identify areas of market inefficiency that active management can exploit. The EMH has been refined to allow for imperfect information, various costs (transaction, financing, and agency), and behavioral biases.

Under the rational explanation of behavioral biases, losses during bad times are compensated for by high returns. Under the behavioral explanation, it is agents' under- or overreactions to news that generates high returns. Market barriers may make it difficult to take advantage of mispricings.

Concept Checkers

1. Which of the following concepts would least likely meet the definition of a factor?
   A. Market.
   B. Volatility.
   C. Hedge funds.
   D. Momentum investing style.

2. According to the capital asset pricing model (CAPM), in equilibrium, all investors hold the mean-variance efficient portfolio. Which of the following investor types is an exception to this assumption?
   A. Infinitely risk-averse investors.
   B. Infinitely risk-tolerant investors.
   C. Investors who hold some of the risk-free asset.
   D. Investors who hold the market portfolio.

3. Assets that have losses during periods of low market returns have:
   A. low betas and low risk premiums.
   B. high betas and low risk premiums.
   C. low betas and high risk premiums.
   D. high betas and high risk premiums.

4. Which of the following statements best describes the relationship between asset payoffs and "bad times" events (high inflation, low economic growth, or both)?
   A. The higher the expected payoff of an asset in bad times, the higher the asset's expected return.
   B. The higher the expected payoff of an asset in bad times, the lower the asset's expected return.
   C. The expected payoff of an asset in bad times is unrelated to the asset's expected return, because it depends on investor preferences.
   D. The expected payoff of an asset in bad times is unrelated to the asset's expected return, because arbitrageurs eliminate any expected return potential.

5. Which of the following statements least likely represents a limitation of the capital asset pricing model (CAPM)?
   A. All investors are price takers.
   B. Information is costless to obtain.
   C. All investors have the same expectations.
   D. There are uniform taxes and transaction costs.

Concept Checker Answers

1. **C** Assets, including corporate bonds, private equity, and hedge funds, are not considered factors themselves, but contain many factors, such as equity risk, interest rate risk, volatility risk, and default risk.

   Some assets, like equities and government bonds, can be thought of as factors themselves. Factors may also include the market (a tradable investment factor), interest rates, or investing styles (including value/growth, low volatility, or momentum).

2. **A** According to the CAPM, all investors hold a combination of the risky mean-variance efficient market portfolio and the risk-free asset. All investors hold the same market portfolio (therefore the mean-variance efficient portfolio is the market portfolio), and it is only the quantity of holdings that differs among investors. The only exception to this assumption is an *infinitely* risk-averse investor, who would only hold the risk-free asset.

3. **D** Assets that have losses during periods of low market returns have *high* betas (high sensitivity to market movements), which indicates they are risky and, therefore, should have *high* risk premiums. Low beta assets have positive payoffs when the market performs poorly, making them valuable to investors. As a result, investors do not require high risk premiums to hold these assets.

4. **B** The higher the expected payoff of an asset in bad times, the lower the asset's expected return. Assets that have a positive payoff in bad times are valuable to hold, leading to high prices and, therefore, low expected returns.

5. **D** The CAPM does not assume *uniform* taxes and transaction costs; it assumes there are *no* taxes or transaction costs (i.e., frictionless markets). The other limiting assumptions of the CAPM include:

   1. Investors only have financial wealth.
   2. Investors have mean-variance utility.
   3. Investors have a single period investment horizon.
   4. Investors have homogeneous (identical) expectations.
   5. All investors are price takers.

Factors

Exam Focus

Macroeconomic factors have been linked to asset returns. The most important macro factors that affect returns are economic growth, inflation, and volatility. Volatility risk can be mitigated by investing in low-volatility assets or buying volatility protection in the derivatives market (e.g., buying put options). The capital asset pricing model (CAPM) is a single-factor model that relates asset returns to market risk. The Fama-French model is a multifactor model that adds a size factor and a value factor to the original CAPM market factor to explain stock returns. A momentum factor can also help explain asset returns. The momentum strategy far outpaces the size and value-growth strategies in terms of returns. However, momentum strategies are prone to crashes. For the exam, understand the risk and return profiles of each factor. Also, be aware of rational and behavioral explanations for each factor.

Value Investing

LO 63.1: Describe the process of value investing, and explain reasons why a value premium may exist.

Risk premiums are driven by **factors**. Economy-wide (i.e., fundamental-based) factors such as inflation, volatility, productivity, economic growth, and demographics drive risk premiums. Additionally, factors related to tradeable investment styles such as momentum investing, value investing, and investing based on firm size drive returns.

A company's **book value** (i.e., net worth) per share is equal to total assets minus total liabilities divided by shares outstanding. It indicates, on a per-share basis, what a company would be worth if it liquidated its assets and paid off its liabilities. Value stocks have high book-to-market ratios while growth stocks have low book-to-market ratios, where "market" indicates the company's stock price. An investment strategy that is long value stocks and short growth stocks is called a **value-growth strategy**.

Historically, value stocks have significantly outperformed growth stocks. One dollar invested in a value-growth strategy in 1965 would be worth more than $6 around 2012, with a peak value of nearly $8 in 2006 and 2007. During the more than 40-year period, value stock returns experienced a sharp downturn during the tech boom, during the late 1990s, during the financial crisis in 2007–2009, and again in 2011. Overall, however, value investing appears to work. Are returns higher than growth investing returns due to a systematic factor? Alternatively, is there a value risk premium? Risk factors offer premiums to investors to compensate them for bearing losses in bad times, like the late 1990s and 2007–2009. Rational and behavioral explanations for the value premium will be discussed in detail in LO 63.5.

Macroeconomic Factors

LO 63.2: Explain how different macroeconomic risk factors, including economic growth, inflation, and volatility affect risk premiums and asset returns.

Macroeconomic factors, such as increasing inflation or slowing economic growth, affect all investors to varying degrees. Most, though not all, investors are hurt by rising inflation, slowing economic growth, or both. But it is not the level of the factor that matters, it is the shock (i.e., unanticipated changes) to a factor. For example, asset prices generally fall when inflation unexpectedly increases. Economic growth, inflation, and volatility are the three most important macro factors that affect asset prices.

Economic Growth

Risky assets like equities generally perform poorly during periods of low economic growth. Less-risky assets like bonds, and especially government bonds, tend to perform well during periods of slow growth. For the investor who can weather a downturn easily, she should invest in equities because returns will be greater over the long run. Periods of stronger growth generally last longer than downturns. For the investor who cannot bear large losses during a period of slow growth, she should invest in bonds. Her portfolio will likely perform better during the downturn but worse in the long run.

Figure 1 reports the returns of large and small stocks, as well as government, investment grade, and junk (high-yield) bonds during expansions and retractions as defined by the National Bureau of Economic Research (NBER). Returns are from Ibbotson Morningstar and cover the period 1952 through 2011. During periods of recession, government and investment grade bonds outperform equities and high-yield bonds, yielding 12.3% and 12.6%, respectively. During expansion periods, equities outperform bonds with large stocks yielding 12.4% and small stocks yielding 16.8%. High-yield bond returns appear indifferent to changes in economic growth, yielding 7.4% in recessions and 7.7% in expansions.

Figure 1 also reports returns based on quarter-on-quarter real GDP growth and quarter-on-quarter consumption growth (i.e., real personal consumption expenditures). The patterns are similar to those exhibited by NBER expansion/recession data. Equities outperform in periods of high real GDP growth and high consumption growth, while bonds outperform in periods of low real GDP growth and low consumption growth. High-yield bonds perform slightly better in high-growth periods.

Figure 1: Investment Returns During Expansions and Recessions

				Corporate Bonds	
	Large Stocks	*Small Stocks*	*Government Bonds*	*Investment Grade*	*High Yield*
Returns					
Full Sample	11.3%	15.3%	7.0%	7.0%	7.6%
Business Cycles					
Recessions	5.6%	7.8%	12.3%	12.6%	7.4%
Expansions	12.4%	16.8%	5.9%	6.0%	7.7%
Real GDP					
Low	8.8%	12.2%	10.0%	9.7%	7.0%
High	13.8%	18.4%	3.9%	4.4%	8.2%
Consumption					
Low	5.6%	5.6%	9.6%	9.1%	7.1%
High	17.1%	25.0%	4.4%	5.0%	8.2%
Inflation					
Low	14.7%	17.6%	8.6%	8.8%	9.2%
High	8.0%	13.0%	5.4%	5.3%	6.0%

In terms of volatility, both stocks and bonds are more volatile during downturns and periods of low growth. For example, large stock return volatility was 23.7% during recessions and 14.0% during expansions. Government bonds perform best during recessions but are also more volatile during these periods (15.5% volatility during recessions and 9.3% volatility during expansions).

Inflation

High inflation is generally bad for both stock and bond prices and returns. Figure 1 indicates that all categories perform better in low inflation versus high inflation periods. Volatilities are also higher in high inflation periods. Large and small stocks return 14.7% and 17.6%, respectively, during low inflation periods, and 8.0% and 13.0% during high inflation periods. Bond yields of 8.6%, 8.8%, and 9.2% (government, investment grade, and high-yield bonds, respectively) during low inflation periods exceeded returns during high inflation periods by approximately 3.0%. Bonds are fixed payment securities. As such, it is clear that bonds should perform poorly in high inflation times. Inflation lowers real bond returns. It is less clear that stocks perform poorly in high inflation times since they represent ownership of real, productive companies, not a claim to a stream of fixed cash flows.

Volatility

Volatility is an important risk factor for many asset classes. The CBOE Volatility Index (VIX) represents equity market volatility. The correlation between the VIX and stock returns has historically indicated a negative relationship (correlation coefficient of –0.39 between 1986 and 2011). This means that stock returns tend to drop when the VIX (equity volatility) increases.

The financial leverage of companies increases during periods of increased volatility because debt stays approximately the same while the market value of equity falls. The negative relationship between stock returns and volatility is called the **leverage effect**. As financial leverage increases, equities become riskier and volatility increases. Additionally, higher volatility increases the required rates of return on equities, pushing stock prices down. Thus, there are two paths to lower stock returns resulting from higher volatility:

1. When market volatility increases, the leverage effect suggests a negative relationship between stock returns and volatility.

2. When market volatility increases, discount rates increase and stock prices decline so that future stock returns can be higher (to compensate for the higher volatility). The capital asset pricing model (CAPM) supports this second path.

Other Macroeconomic Factors

Other macroeconomic factors, including productivity risk, demographic risk, and political risk, also affect asset returns. **Productivity shocks** affect firm output. In periods of falling productivity, stock prices fall (like in the 1960s and 1970s). In periods of improving productivity (like the 1980s and 1990s computer revolution) productivity shocks are positive and stock prices generally increase. The correlation between productivity shocks and stock returns is relatively high (approximately 50%).

New models, called *dynamic stochastic general equilibrium* (DSGE) macro models, indicate that economic variables change over time due to the actions of agents (i.e., consumers, firms, governments, and central banks), technologies (and their impact on how firms produce goods and services), and the way that agents interact (i.e., markets). A benchmark model created by Smets and Wouters (2007)[1] specifies seven shocks that impact the business cycle. They are: (1) productivity, (2) investment, (3) preferences, (4) inflation, (5) monetary policy, (6) government spending, and (7) labor supply.

Like productivity shocks, **demographic risk**, which can be interpreted as a shock to labor output, is a shock to firm production. Economic *overlapping generation* (OLG) models include demographic risk as a factor affecting investor returns. In these models, generations overlap. Young, middle-age, and retired workers exist in a system. Workers earn income and save during the young and middle-age stages. Retired workers disinvest. As a cohort progresses through life, they join others already in the cohort but born at an earlier time. According to several OLG models, events that shock the composition of the cohort, like World Wars I and II, infectious diseases, like the Spanish Flu of 1918, and the baby boom, which followed World War II, impact returns. For example, one model predicts that stock prices will fall when baby boomers retire as they liquidate assets to fund consumption. This would occur if there are relatively fewer young and middle-age investors to offset the asset liquidation of retirees. If there are a greater number of young and middle-age workers, relative to retirees, the impact will be lessened (or even overcome). Another study shows that risk aversion increases with age and that as the average age of the population increases, the equity risk premium should also increase. Note that it is important to use cross-country data in demographic studies.

1. Frank Smets and Rafael Wouters, "Shocks and Frictions in US Business Cycles: A Bayesian Dynamic Stochastic General Equilibrium Approach," *American Economic Review* 97, no. 3 (2007): 586–606.

Political (or sovereign) risk, once thought only important in emerging markets, increases risk premiums. The financial crisis of 2007–2009 made clear that political risk affects both developed and undeveloped countries.

Managing Volatility Risk

LO 63.3: Assess methods of mitigating volatility risk in a portfolio, and describe challenges that arise when managing volatility risk.

Volatility can be mitigated by investing in less volatile assets. As one would expect, bond returns are less impacted by volatility in equity markets (than equity returns). However, bonds are not necessarily a safe haven. Correlation between changes in the VIX and bond returns was 0.12 (between 1986 and 2011). This means bonds perform better than stocks (with a correlation coefficient of –0.39) when the VIX is rising, but the relationship is not highly positively correlated. For example, during the recent financial crisis, volatility was a factor that caused risky assets, bonds and stocks included, to fall simultaneously. The VIX can also capture uncertainty. Some research indicates that uncertainty risk is different from volatility risk, but the two risks are highly correlated.

Other investment approaches also perform poorly in periods of increased volatility. A number of strategies have a large exposure to volatility risk. For example, currency strategies perform poorly during periods of high volatility. For investors who want to avoid volatility, they can buy put options (i.e., protection against volatility). Out-of-the-money puts, which pay off during periods of high volatility, provide hedges against volatility risk.

In sum, there are two basic approaches to mitigating volatility risk. They are:

- Invest in less volatile assets like bonds, understanding that they too can perform poorly during extreme circumstances such as the 2007–2009 financial crisis.
- Buy volatility protection in the derivatives market (e.g., buy out-of-the-money put options).

Volatility Premiums

Typically, an investor buys an asset, like a stock, and the long position produces a positive expected return. In other words, on average, assets have positive premiums. However, volatility has a negative premium. To collect the volatility premium, one must sell volatility protection (e.g., sell out-of-the money put options). Realized volatilities are lower on average (by approximately 2%–3%) than VIX implied volatilities. This means that, on average, options are expensive and investors can collect volatility premiums by shorting volatility strategies.

During normal economic periods, selling volatility provides high, stable payoffs. However, when there is a crash, like the 2007–2009 financial crisis, sellers of volatility suffer large, negative returns. A volatility (swap) index constructed by Merrill Lynch indicates steadily (with minor blips) increasing cumulative returns between January 1989 and December 2007, until the financial crisis. Between September and November 2008, losses were nearly 70%. Considering the data leading up to the crisis (through December 2007), selling volatility looked like easy money. Considering the whole sample period, including the crisis,

the data indicates negative skewness of –8.26. Without the crisis (i.e., only considering the data up to December 2007) the negative skewness was a mere –0.37.

Professor's Note: Selling volatility is like selling insurance. If you sell auto insurance, you collect stable premiums over time but occasionally face a large payout due to a car accident. The same is true for selling out-of-the-money put options. The seller collects option premiums for years, then a disaster happens, like the 2007–2009 financial crisis, and the seller faces massive losses. Option purchasers know in advance what they can lose, the option premium, but sellers do not. Thus, during a market crash, losses could be massive for volatility sellers. Only investors who can tolerate periods of high volatility, which often coincide with losses (sometimes very large losses), should sell volatility.

Academics have estimated a relationship between the expected market risk premium $[E(R_M) - R_F]$ and volatility. The equation is shown as follows:

$$E(R_M) - R_F = \bar{\gamma} \times \sigma_M^2$$

where σ_M^2 is equal to the variance of the market return and $\bar{\gamma}$ represents the average investor's risk aversion. While the coefficient $\bar{\gamma}$ is positive in theory, various studies have estimated it as either positive, negative, or zero. Again, though, whether positive or negative, only those investors who can withstand massive losses during periods of high volatility should sell volatility.

Dynamic Risk Factors

LO 63.4: Explain how dynamic risk factors can be used in a multifactor model of asset returns, using the Fama-French model as an example.

The **capital asset pricing model** (CAPM) is a single-factor model. In the CAPM, the single risk factor is market risk. Stocks that have high exposure to the CAPM market factor perform well when the market performs well and poorly when the market performs poorly. Over the long run, stocks with high betas (i.e., a high market risk factor) should have higher returns than the market return. Returns are higher for high beta stocks to compensate investors for losses during bad periods.

The market portfolio can be readily traded via low-cost index funds, stock futures, and exchange-traded funds (ETFs). In general, macro factors, like political, inflation, and growth risks, are not directly traded (volatility risk is the exception). As a result, dynamic factors can be easily employed in portfolios. The best known example of a tradeable multifactor model is called the **Fama and French model**, introduced in 1993.[2]

2. Eugene F. Fama and Kenneth R. French, "Common Risk Factors in the Returns on Stocks and Bonds," *Journal of Financial Economics* 33 (1993): 3–56.

Professor's Note: In the academic finance literature "style factors," "investment factors," and "dynamic factors" are used interchangeably. Practitioners also refer to these factors as "smart beta" or "alternative beta." Fama and French were the first to develop a multifactor model that captured these effects.

The Fama-French model (called the Fama-French three-factor model) explains asset returns based on three dynamic factors. The model includes:

- The traditional CAPM market risk factor (MKT).
- A factor that captures the **size effect** (SMB).
- A factor that captures the **value/growth effect** (HML).

The Fama-French three-factor model is expressed as follows:

$$E(R_i) = R_F + \beta_{i,MKT} \times E(R_M - R_F) + \beta_{i,SMB} \times E(SMB) + \beta_{i,HML} \times E(HML)$$

Following the market factor, the second factor in the model is SMB. The SMB factor refers to the difference between the returns on small stocks (small market capitalization) versus big stocks (large market capitalization). In other words, the risk factor is small stock returns minus big stock returns, thus SMB. Historically, small-cap stocks have outperformed large-cap stocks. This factor captures the higher performance of small companies relative to large companies. Note, however, that the average stock only has market exposure. Every stock cannot be large, and every stock cannot be small.

The third factor in the model is HML. This factor captures the return differential of high book-to-market stocks versus low-book-to-market stocks. The ratios are calculated as book value divided by market capitalization. Recall that a value strategy consists of buying low-priced stocks (i.e., taking a long position in low-priced stocks) and selling high-priced stocks (i.e., shorting high-priced stocks), normalized by book value. Growth stocks have high stock prices relative to book values, and value stocks have low stock prices relative to book values. Historically, value stocks have outperformed growth stocks. Thus, the Fama-French factors are constructed to capture size (SMB) and value (HML) premiums (known as **factor-mimicking portfolios**).

A value investor, who buys stocks that are perceived as trading below their fundamental value, would have a positive HML beta. Relative to the CAPM expected return, the value investor's return adjusts upward by $\beta_{i,HML} \times E(HML)$. Thus, the overall risk premium increases above the single-factor CAPM risk premium. Likewise, the overall risk premium is adjusted down by $\beta_{i,HML} \times E(HML)$ for growth stocks. This is because growth stocks have negative HML betas, so expected returns are adjusted downward.

In the CAPM, both the average stock beta and the market beta equal one. In the Fama-French model, the HML and SMB betas are centered on zero. The average investor earns the market return as the average stock (or portfolio of stocks) does not have a value or size tilt. This means the investor must specifically choose a value play or a size play, to benefit from the HML and SMB factors. Also, the CAPM and Fama-French models assume betas are constant, but empirical research indicates they vary and increase during bad times.

Value and Momentum Investment Strategies

LO 63.5: Compare value and momentum investment strategies, including their risk and return profiles.

The fact that small stocks tend to outperform big stocks, after adjusting for the firm's beta, was discovered by Banz (1981)[3] and similarly by Reinganum (1981).[4] Following the publication of this finding, the effect disappeared. In other words, if you examine the returns to an SMB strategy from 1965 to 2011, returns to the strategy peak in the early 1980s, with no evidence of a small stock premium in subsequent years. The two possible explanations for the disappearing size effect are as follows:

- *Data mining*. Fischer Black (1993)[5] suggested data mining following the publication of the Fama and French study. If a finding is discovered with *in-sample data* (i.e., in the data used in the original study) but is not substantiated in further studies using *out-of-sample data*, then data mining provides a possible explanation for the result.
- *Investor actions*. Upon the publication of the Banz and Reinganum studies, investors, acting rationally, bid up the prices of small-cap stocks until the SMB effect was removed. This is consistent with the efficient market hypothesis (EMH) in which investors exploit anomalies until they can no longer profit from them. If this is true, then size should be removed as a risk factor in the Fama-French model.

Note that small stocks do tend to have higher returns (i.e., weak size effect), partially because they are less liquid than large-cap stocks. Also, the value and momentum effects, discussed next, are stronger for small stocks. However, the ability to capture small-cap excess returns over the market (on a risk-adjusted basis) is no longer present.

Value Investing

Unlike the disappearing size premium, the value risk premium has provided investors with higher risk-adjusted returns for more than 50 years. Value strategies have suffered periods of loss, including the 1990s recession, the dot com bull market of the late 1990s, and the 2007–2009 financial crisis. The notion of value investing dates back to when Graham and Dodd (1934)[6] published *Security Analysis* with a focus on finding stocks that had prices lower than their fundamental values.

There are generally two explanations for the value premium, one rational and the other behavioral.

Rational Theories of the Value Premium

Value stocks move with each other and co-vary with growth stocks in the rational story about the reason a value premium exists. They perform well together and poorly together.

3. Rolf W. Banz, "The Relationship Between Return and Market Value of Common Stocks," *Journal of Financial Economics* 9 (1981): 3–18.
4. Marc R. Reinganum, "Misspecification of Capital Asset Pricing: Empirical Anomalies Based on Earnings' Yields and Market Values," *Journal of Financial Economics* 9, no. 1 (1981): 19–46.
5. Fischer Black, "Beta and Return," *Journal of Portfolio Management* 20, no. 1 (1993): 8–18.
6. Benjamin Graham and David Dodd, *Security Analysis* (New York: McGraw-Hill, 1934).

Value is risky and, as such, value stocks sometimes perform poorly. The value premium is compensation for these periods of poor performance, for losing money during bad times. Value did perform poorly during the bull market in the late 1990s. This means rational stories must define "bad times" and that value earns a premium on average, not all of the time. Also, not all value risk can be diversified away. The remaining value risk is captured in the value premium.

Labor income risk, investment growth, "luxury" consumption, long-run consumption risk, and housing risk are factors that have been used to explain the value premium. Value stock betas often increase during bad times defined by these risks, causing value stocks to be particularly risky. Macro-based and CAPM risk factors turn out to be the same factors that affect value firms.

Consider the difference between growth and value firms. Growth firms are more adaptable and can adjust when times change because the bulk of their capital is human capital. Value firms are more "old school" with capital in the form of fixed assets that cannot be redeployed when times change. Thus, value firms have *high and asymmetric adjustment costs*. This makes value stocks fundamentally more risky than growth stocks.

The average investor holds the market portfolio. Some investors choose a value tilt and others a growth tilt. The decision boils down to how well the investor can withstand bad times. Given the factors defined previously as bad for value (i.e., labor income risk, investment growth, etc.), the investor must ask himself, "Are these times bad for me (versus bad in general)?" If, for example, an investor can manage well during times of low investment growth, that is not a bad time for that investor relative to the average investor. The investor, who has a comparative advantage in holding value stocks, can bear value risk and, therefore, can earn the value premium.

Behavioral Theories of the Value Premium

Behavioral theories of the value premium revolve around two basic ideas:
(1) overextrapolation and overreaction and (2) loss aversion and mental accounting.

Overextrapolation and overreaction. Investors have a tendency to assume that past growth rates will continue in the future. This is called **overextrapolation**. For example, a technology company may have a period of tremendous growth as it developed new products that are in high demand. Many investors may assume that this company will continue this growth into the future. Investors often bid up the prices of growth stocks beyond their intrinsic values due to unwarranted optimism. Prices fall when the high expected growth doesn't materialize, leading to lower returns than those earned on value stocks.

Loss aversion and mental accounting. Investors dislike losses more than they like gains (i.e., **loss aversion**), and they tend to view investment gains and losses on a case-by-case basis rather than on a portfolio basis (known as *mental accounting*). Barberis and Huang (2001)[7] use this notion to explain the value premium. They argue that the reason value stocks have high book-to-market values is that they have undergone a period of very poor

7. Nicholas Barberis and Ming Huang, "Mental Accounting, Loss Aversion, and Individual Stock Returns," *Journal of Finance* 56, no. 4 (2001): 1247–92.

performance. Loss-averse investors view the stock as risker and, therefore, require a higher rate of return.

Professor's Note: The extrapolation/overreaction behavioral explanation of the value premium is different from the rational one in that in the behavioral explanation, value stocks are not riskier, they are just cheap relative to growth stocks. Investors tend to underestimate the growth prospects of value stocks and overestimate the growth prospects of growth stocks. This bids up the prices of growth stocks and bids down the prices of value stocks, allowing value stocks to outperform on average. Investors must determine if they tend to overextrapolate or not. Investors who act like other average, non-over or under-reacting investors should hold the market portfolio. Investors who overextrapolate will lean toward growth stocks, and those who underreact will lean toward value stocks.

Why are there not enough value investors in the market to push up prices and remove the value premium, as described in the section on the small-cap effect? Maybe investors find value investing difficult, although it is easy to sort stocks on a book-to-market basis using internet screening tools. Perhaps investment horizons must be too long to engage in value investing. The book-to-market value effect described here requires at least a three month to six month horizon. It is possible that not enough institutions have a long enough investment horizon to adopt a value investing approach.

Value investing exists in all asset classes. Strategies include:

- *Riding the yield curve* in fixed income (i.e., capturing the duration premium).
- *Roll return* in commodities (i.e., an upward or downward sloping futures curve determines the sign of the return).
- *Carry* in foreign exchange (e.g., long positions in currencies with high interest rates and short positions in currencies with low interest rates). In this case, high yields are akin to low prices in equity value strategies.

Retail investors can implement value strategies via low-cost index products. Large, institutional investors can, at least theoretically, cheaply implement value strategies across markets.

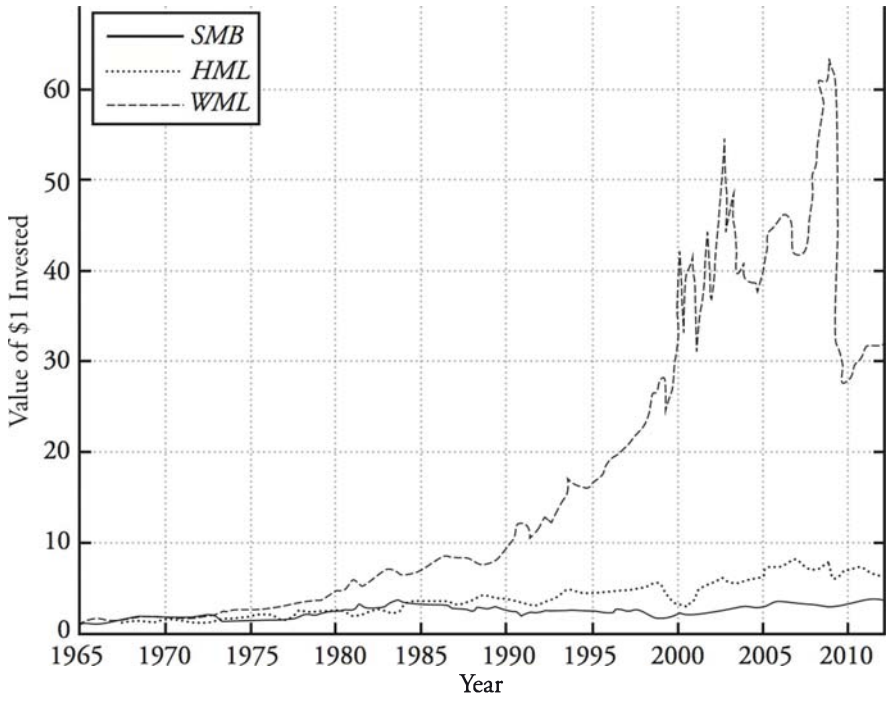
Momentum Investing

In 1993, the same year Fama and French captured the size and value/growth effects, Jagadeesh and Titman[8] identified a **momentum effect.** Momentum strategies (also called **trend investing**) consist of buying stocks that have gone up over a period (e.g., six months or so) and short stocks that have fallen over the same period (i.e., buy past "winners" and sell past "losers"). The momentum factor, WML, stands for "winners minus losers." It is also sometimes denoted UMD for "up minus down," buying stocks that have gone up in price and selling stocks that have gone down in price. A momentum premium is observed in fixed income (government and corporate bonds), international equities, commodities, real estate, and specific industries and sectors.

8. Narasimhan Jegadeesh and Sheridan Titman, "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency," *Journal of Finance* 48, no. 1 (1993): 65–91.

The returns to momentum investing exceed size and value investing premiums by a wide margin. Figure 2 illustrates the differences in returns across the three strategies. One dollar invested in the WML premium in January 1965 reached a high of more than $60 before following precipitously (below $30) during the 2007–2009 financial crisis. Correlation between the value premium and the momentum premium was only approximately –0.16 during this period. This means that value returns are not opposite momentum returns.

Figure 2: Returns for SMB, HML, and WML strategies



Value and momentum strategies are, however, opposite each other in the following sense. Value investing is inherently stabilizing. It is a *negative feedback strategy* where stocks that have fallen in value eventually are priced low enough to become value investments, pushing prices back up. Momentum is inherently destabilizing. It is a *positive feedback strategy* where stocks that have been increasing in value are attractive to investors, so investors buy them, and prices increase even more. Momentum investing can lead to crashes (e.g., the more than 50% drop during the 2007–2009 financial crisis). Notice that value and growth returns did not fall in quite so dramatic a fashion. An investor following a momentum strategy should still rebalance his portfolio.

Momentum is often added to the Fama-French model as follows:

$$E(R_i) = R_F + \beta_{i,MKT} \times E(R_M - R_F) + \beta_{i,SMB} \times E(SMB) + \beta_{i,HML} \times E(HML) + \beta_{i,WML} \times E(WML)$$

As mentioned, momentum can be riskier than value or size investing in that it is more prone to crashes. There have been 11 momentum crashes on record: seven during the 1930s Great Depression, three during the financial crisis starting in 2007, and one in 2001. During the 2007–2009 crisis, financial stocks were hit hard. Losers tend to keep losing, and they likely would have, but the government bailout put a floor on stock prices. Momentum

investors were short these stocks. When the government bailed out financial firms and other firms that were hit hard, momentum investors experienced large losses as the market rebounded. During the Great Depression, policymakers also influenced asset prices, causing losses to momentum investors.

Momentum risk includes:

- Tendency toward crashes.
- Monetary policy and government risk (i.e., the government gets in the way of the natural progression of asset prices).
- Macro factors such as the business cycle, the state of the stock market, and liquidity risk.

Behavioral explanations suggest that investor biases explain momentum. Investors overreact (a delayed overreaction) to good news about firms. This causes prices to drift upward. Alternatively, investors may underreact to good news, causing prices to increase less than they should have given the good news. As investors acquire more information, prices go up in the next period. Thus, behavioral explanations for the momentum premium fall into two, difficult-to-distinguish camps:

1. *Overreaction to good news.* In some cases overconfident, informed investors, like retail investors and hedge fund managers, observe positive signals in stock performance. They attribute the performance to their own skill. The overconfidence leads to overreaction, pushing prices up above their fundamental values.

2. *Underreaction to good news.* In this case, "news watchers" ignore information in the history of stock prices and other investors trade only on history (i.e., past price signals) and ignore fundamental information about the firm. In both cases, information is only partially incorporated into stock prices, causing an underreaction.

Whether there is momentum that results from overreaction or from underreaction, prices eventually revert to their fundamental values over the long run. An investor considering momentum investing must assess whether he leans toward overreaction or underreaction. Also, the investor must know that he can tolerate large losses during "crash" periods, historically concentrated around periods when policymakers (e.g., central banks) interrupt momentum, changing the course that asset prices would naturally take. In sum, assets are exposed to factor risks like value and momentum. Factor premiums compensate investors for losses during bad times.

Key Concepts

LO 63.1

A value-growth investment strategy is long value stocks and short growth stocks. Value stocks have high book-to-market ratios, and growth stocks have low book-to-market ratios. Historically, value stocks have significantly outperformed growth stocks.

Risk premiums, including a value premium, exist to compensate investors for losses experienced during bad times. There are rational and behavioral explanations for why a value premium may exist. Value stocks are risky, thus the value premium compensates investors for losses during bad times (rational explanation). Investors undervalue the growth prospects of value stocks and overextrapolate past growth into future prospects, overvaluing growth stocks. Value stocks are underpriced relative to their fundamental values, and growth stocks are overvalued, leading to a value premium (behavioral explanation).

LO 63.2

Macroeconomic factors, like inflation and economic growth, affect all investors to varying degrees. Economic growth, inflation, and volatility are the three most important macro factors that affect asset prices. It is unanticipated changes to a risk factor that affect asset prices, not the level of the factor. In other words, it is not the level of inflation, but an unanticipated increase or decrease in inflation that causes stock and bond prices to rise or fall.

- Risky assets generally perform poorly during periods of low economic growth.
- Stocks and bonds generally perform poorly in periods of high inflation.
- Stock returns drop when volatility (measured by the VIX) increases.

Other macroeconomic factors, like shocks to productivity, demographic risks, and sovereign risks, also affect asset returns.

LO 63.3

Volatility increases in periods of economic stress. There are two basic approaches to mitigating volatility risk:

- Invest in less-volatile assets like bonds. One challenge to managing volatility is that asset prices, including less volatile assets, tend to perform poorly during periods of economic stress (e.g., 2007–2009).
- Buy volatility protection in the derivatives market (e.g., buy out-of-the-money put options). Sellers of volatility protection (i.e., those selling put options) collect volatility premiums.

LO 63.4

The Fama-French model explains asset returns based on three dynamic factors. The factors are:

- The traditional CAPM market risk factor.
- A factor that captures the size effect (SMB or small cap minus big cap). Historically, small-cap stocks outperform large-cap stocks. The strategy is long small-cap stocks and short large-cap stocks.
- A factor that captures the value/growth effect (HML or high book-to-market value minus low book-to-market value). Value stocks tend to outperform growth stocks. The value-growth strategy is long value stocks and short growth stocks.

LO 63.5

A value strategy is long value stocks and short growth stocks. A momentum strategy is long "winners" (i.e., stocks that have gone up in value over the last six months or so) and short "losers" (i.e., stocks that have gone down in value over the last six months or so). A momentum strategy has vastly outperformed both value-growth and size strategies since 1965. However, momentum strategies are subject to crashes. Rational and behavioral explanations can be used to describe both value and momentum risk premiums.

Concept Checkers

1. A low book-to-market value ratio is indicative of a:
   A. value stock.
   B. growth stock.
   C. small-cap stock.
   D. large-cap stock.

2. Which of the following asset classes has approximately the same returns in high economic growth periods and low economic growth periods?
   A. Small-cap stocks.
   B. Large-cap stocks.
   C. Government bonds.
   D. High-yield bonds.

3. Which of the following investment options provides a means of mitigating volatility risk?
   A. Buying put options.
   B. Selling put options.
   C. Buying equities.
   D. Buying call options.

4. Which of the following is not a factor in the Fama-French three-factor model?
   A. The capital asset pricing model market risk factor.
   B. The small capitalization minus big capitalization risk factor.
   C. The winners minus losers risk factor.
   D. The high book-to-market value minus low book-to-market value risk factor.

5. Which of the following investment strategies stabilizes asset prices?
   A. A value investment strategy.
   B. A momentum investment strategy.
   C. A size investment strategy.
   D. Value, momentum, and size strategies all stabilize asset prices.

Concept Checker Answers

1. **B** A company's book value per share is equal to total assets minus total liabilities all divided by shares outstanding. It indicates, on a per-share basis, what a company would be worth if it liquidated its assets and paid off its liabilities. Value stocks have high book-to-market ratios while growth stocks have low book-to-market ratios.

2. **D** During periods of recession, government and investment-grade bonds outperform equities and high-yield bonds. During expansion periods, equities outperform bonds. High-yield bond returns appear indifferent to changes in economic growth, yielding 7.4% in recessions and 7.7% in expansions.

3. **A** There are two basic approaches to mitigating volatility risk. They are investing in less volatile assets like bonds (instead of stocks) or buying volatility protection in the derivatives market, such as buying out-of-the-money put options.

4. **C** The Fama-French model includes the following three risk factors:
   - The traditional capital asset pricing model market risk factor.
   - A factor that captures the size effect (SMB).
   - A factor that captures the value/growth effect (HML).

   The winners minus losers (WML) momentum factor was discovered by Jagadeesh and Titman.

5. **A** Value and momentum are opposite each other in that value investing is inherently stabilizing. It is a *negative feedback strategy* where stocks that have fallen in value eventually are priced low enough to become value investments, pushing prices back up. Momentum is inherently destabilizing. It is a *positive feedback strategy* where stocks that have been increasing in value are attractive to investors, so investors buy them, and prices increase even more.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Alpha (and the Low-Risk Anomaly)

Topic 64

Exam Focus

Investors are interested in generating alpha, which is the return earned in excess of a benchmark. It was traditionally thought that higher risk produced higher returns. However, in practice, strategies focused on lower volatility have actually been found to produce higher returns than higher-volatility investments. For the exam, be able to explain the impact of benchmark section on alpha. Also, understand how to apply factor regression to construct a benchmark with multiple factors, and how to measure alpha against that benchmark. Finally, be familiar with the potential explanations for return anomalies with regard to low risk.

Low-Risk Anomaly

LO 64.1: Describe and evaluate the low-risk anomaly of asset returns.

The capital asset pricing model (CAPM) from traditional finance states that there should be a positive relationship between risk and return. Higher risk, as measured by beta, should have a higher return. The **low-risk anomaly** appears to suggest the exact opposite. This anomaly finds that firms with lower betas and lower volatility have higher returns over time. For example, over a five-year period from 2011–2016, the cumulative return for a low volatility fund (iShares Edge MSCI Minimum Volatility USA ETF) was 68.75% relative to the cumulative return of 65.27% for the S&P 500 Index ETF.

Alpha, Tracking Error, the Information Ratio, and the Sharpe Ratio

LO 64.2: Define and calculate alpha, tracking error, the information ratio, and the Sharpe ratio.

Professor's Note: We will demonstrate the calculations for these measures along with other performance measures later in this book (Topic 70).

Alpha is often interpreted as a measure of investor skill, but it is really just a statement of average performance in excess of a benchmark. Excess return (R_t^{ex}) can be seen as the difference between the return of an asset (R_t) and the return of the asset's benchmark (R_t^B).

$$R_t^{ex} = R_t - R_t^B$$

Excess return is also sometimes called **active return**. This phrase assumes that the benchmark is passive and can be achieved without investment knowledge or human intervention. The S&P 500 Index and the Russell 1000 Index are commonly used large-cap benchmarks. If the benchmark is passive, then any additional return that the investor achieves is from doing something different from the benchmark, which by definition is active.

We compute alpha (α) by finding the average excess return for T observations.

$$\alpha = \frac{1}{T}\sum_{t=1}^{T} R_t^{ex}$$

To fully understand the concept of alpha, we also need to understand tracking error and the information ratio. **Tracking error** is the standard deviation of excess returns. It measures the dispersion of the investor's returns relative to their benchmark.

$$\text{tracking error} = \bar{\sigma} = \text{standard devation}(R_t^{ex})$$

When a professional investment manager uses active strategies, there is often a constraint placed on the amount of tracking error permitted. Larger tracking errors indicate that the manager has more freedom in decision making.

One easy way to monitor alpha is to standardize it using tracking error. The ratio of alpha to tracking error is known as the **information ratio** (IR), and it is a good way to monitor risk-adjusted returns for active asset managers. Active investment choices can be ranked based on their IR scores.

$$IR = \frac{\alpha}{\bar{\sigma}}$$

Sometimes the benchmark for an asset manager is the risk-free rate (R_F). In this case, alpha is measured as the return earned on an investment (R_t) in excess of the risk-free rate.

$$\alpha = R_t - R_F$$

When the risk-free rate is the appropriate benchmark, the best way to measure risk-adjusted returns is to use the **Sharpe ratio**. This measure has alpha in the numerator and the standard deviation of the asset in the denominator.

$$\text{Sharpe ratio} = \frac{\bar{R}_t - \bar{R}_F}{\sigma}$$

Benchmark Selection for Alpha

LO 64.3: Explain the impact of benchmark choice on alpha, and describe characteristics of an effective benchmark to measure alpha.

The choice of benchmark has a significant impact on the calculated alpha for an investment. Strictly benchmarking to an identifiable index, like the S&P 500 Index, assumes that an asset has a beta of 1.0. What if the true beta is some value other than 1.0? Consider an investment that has a beta of 0.73 and tracking error of 6.16%. The alpha for this investment could be estimated by regressing the excess return of the fund ($R_t - R_F$) against the excess return of the benchmark ($R_t^{SP500} - R_F$). In the following regression equation, you see a calculated alpha of 3.44% and a placeholder for error term (ε_t) because we never know, in advance, how an individual observation will deviate from our model at any point in time.

$$R_t - R_F = 0.0344 + 0.73(R_t^{SP500} - R_F) + \varepsilon_t$$

We can rearrange this formula to isolate only the expected return on our investment. Doing so, we find that our customized benchmark should actually be invested 27% in the risk-free rate and 73% in the S&P 500 Index. Using a benchmark that recognizes the investment's beta as 0.73, we calculate an alpha of 3.44%, which translates into an IR of 0.5584 (= 0.0344 / 0.0616).

$$R_t = 0.0344 + 0.27(R_F) + 0.73(R_t^{SP500}) + \varepsilon_t$$

If this same investor were to wrongly regress their investment against only the S&P 500 Index, then they would calculate an alpha of 1.50%, which is incorrect because it assumes a beta of 1.0 when the actual beta is 0.73.

$$R_t = 0.015 + R_t^{SP500} + \varepsilon_t$$

Using the wrong benchmark would produce an IR of 0.2435 (= 0.0150 / 0.0616). This suggests that using an incorrect benchmark will understate both the expected alpha and the IR. Inaccurate information may cause an investor to pass on an investment that they otherwise should have accepted.

This illustration leads an investor to wonder: what is the best way to choose a benchmark? An appropriate benchmark can be selected by applying a few different complementary standards. First, the benchmark should be *well-defined*. It should be hosted by an independent index provider, which makes it both verifiable and free of ambiguity. The S&P 500 Index and the Russell 1000 Index are both examples of well-defined large-cap indices. Second, an index should be *tradeable*. If the benchmark is not a basket of tradeable securities that could be directly invested in as an alternative, then the benchmark is not a very good comparison. Third, a benchmark must be *replicable*. This is closely related to the tradability standard. There are some benchmarks, like absolute return benchmarks, that are

not feasible for an investor to replicate. If it cannot be replicated, then the tracking error will be very high. Fourth, the benchmark must be *adjusted for risk*. In the previous example, you can see that the alpha and the IR will be calculated too low if the risk level of the benchmark is too high for the investment in question.

Fundamental Law of Active Management

LO 64.4: Describe Grinold's fundamental law of active management, including its assumptions and limitations, and calculate the information ratio using this law.

Portfolio managers create value, and potentially create alpha, by making bets that deviate from their benchmark. Richard Grinold formalized this intuitive relationship in the **fundamental law of active management.**[1] This fundamental law does not provide a tool for searching for high IR plays, but it does present a good mechanism for systematically evaluating investment strategies. The law states that:

$$IR \approx IC \times \sqrt{BR}$$

The formula for Grinold's fundamental law shows that the information ratio (IR) is approximately equal to the product of the information coefficient (IC) and the square root of the breadth (BR) of an investor's strategy. The **information coefficient** is essentially the correlation between an investment's predicted and actual value. This is an explicit evaluation of an investor's forecasting skill. A higher IC score means that the predictions had a higher correlation (high-quality predictions). **Breadth** is simply the number of investments deployed.

Consider an example of an investor who requires an IR of 0.50. If this investor wants to time the market using an index and plans to only make four investments during the year, then he would need an IC of 0.25 as shown:

$$0.5 = 0.25 \times \sqrt{4}$$

What would happen if this same investor instead decided to deploy a stock selection strategy based on either value or momentum plays? These two strategies both involve taking a high number of bets every year. If they placed 200 bets in a given year, then they would only need an IC of 0.035 instead of 0.25. A lower IC means lower-quality predictions.

$$0.5 = 0.035 \times \sqrt{200}$$

Grinold's fundamental law teaches us about a central tradeoff in active management. Investors need to either play smart (a high IC shows high-quality predictions) or play often (a high BR shows a lot of trade activity). Essentially, investors can be very good at making forecasts and place a small number of bets, or they will need to simply place a lot of bets.

1. Richard C. Grinold, "The Fundamental Law of Active Management," *Journal of Portfolio Management* 15, no. 3 (1989): 30–37.

Grinold's framework ignores downside risk and makes a critical assumption that all forecasts are independent of one another. The Norwegian sovereign wealth fund has used Grinold's fundamental law in practice. Their philosophy is to take a high number of bets using a large list of entirely independent asset managers. This helps to keep forecasts independent and allows them to have reduced reliance on forecasting prowess while still endeavoring to achieve their benchmark IR goals.

In practice, it has also been noted that as assets under management go up, the IC tends to decline. This affects mutual funds, hedge funds, private equity firms, pension funds, and sovereign wealth funds alike. This is one reason why some mutual funds close to new investors and turn away new assets once they reach an internally set size.

Factor Regression and Portfolio Sensitivity

LO 64.5: Apply a factor regression to construct a benchmark with multiple factors, measure a portfolio's sensitivity to those factors, and measure alpha against that benchmark.

Consider the CAPM formula, where $E(R_i)$ is the expected return for asset *i* for a given level of beta exposure, and $E(R_M)$ is the expected return on the market:

$$E(R_i) = R_F + \beta[E(R_M) - R_F]$$

If an investment has a beta of 1.3, then the following formulas demonstrate the algebraic evolution of this expression:

$$E(R_i) = R_F + 1.3[E(R_M) - R_F]$$
$$E(R_i) = R_F + 1.3E(R_M) - 1.3(R_F)$$
$$E(R_i) = -0.3R_F + 1.3E(R_M)$$

In this example, the expected return on a $1 investment in asset *i* should be equal to a portfolio with a short position in the risk-free rate of $0.30 and a long position in the market of $1.30. Any return earned in excess of this unique blend will exceed our expectations and is, therefore, considered to be *alpha*. Using regression, the alpha is approximated as:

$$R_{i,t} - R_F = \alpha + \beta(R_M - R_F) + \varepsilon_{i,t}$$

This exact process was conducted on Berkshire Hathaway stock over the period of January 1990 to May 2012 relative to S&P 500 Index. The results are shown in Figure 1. The monthly alpha coefficient is statistically significant at a 95% confidence level due to the absolute value of the *t*-statistic being greater than 2.0. Most regressions do not produce a statistically significant alpha.

Figure 1: Regression of Excess Returns

	Coefficient	*t-Statistic*
Alpha	0.72%	2.02
Beta	0.51	6.51
Adjusted R^2	0.14	

This regression implies the following CAPM equation:

$$R_B = 0.49R_F + 0.51R_M$$

According to these regression results, a customized benchmark of 49% in the risk-free asset and 51% in the market would produce an expected alpha of 0.72% per month for Berkshire Hathaway. That is 8.6% (0.72% × 12) of annualized expected alpha! Since alpha is the excess return above the actual return, R_i, you can think of alpha using the following formula:

$$\alpha = R_i - [0.49R_F + 0.51E(R_M)]$$

Professor's Note: For Berkshire, it is important to note that their market capitalization has grown from less than $10 billion in the early 1990s to over $220 billion in 2012. In his Annual Letter to Shareholders for 2010, Warren Buffet told shareholders that "the bountiful years, we want to emphasize, will never return. The huge sums of capital we currently manage eliminate any chance of exceptional performance".[2] *Thus, Berkshire Hathaway has acknowledged the law of declining marginal returns due to scale.*

In 1993, Eugene Fama and Kenneth French extended the traditional CAPM-based regression to include additional factors. They controlled for the **size effect** (small companies tend to outperform large companies) and for the **value/growth effect** (value stocks tend to perform better than growth stocks). They formally labeled the size premium as SMB, which stands for "small minus big" (the return on small stocks minus the return on big stocks), and they represented the value premium with HML, which stands for "high minus low" (high book-to-market stocks minus low book-to-market stocks). The factors for SMB and HML are long-short factors. The "small minus big" factor can be visualized as:

SMB = $1 in small caps (long position) – $1 in large caps (short position)

In a similar manner, we can visualize "high minus low" as:

HML = $1 in value stocks (long position) – $1 in growth stocks (short position)

2. Berkshire Hathaway Annual Letter to Shareholders, 2010.

The **Fama and French three-factor model** is constructed as follows:

$$R_i - R_F = \alpha + \beta_{i,MKT} \times (R_M - R_F) + \beta_{i,SMB} \times (SMB) + \beta_{i,HML} \times (HML)$$

The SMB beta will be positive if there is co-movement with small stocks, and it will be negative if there is co-movement with large stocks. If a given asset does not co-move with either small or large companies (i.e., a medium company focus), then its beta coefficient will be zero. Likewise, the HML beta will be positive if the assets have a value focus, and it will be negative if the assets have a growth focus. Applying the Fama-French model to Berkshire Hathaway over the time period of January 1990–May 2012 yields the results displayed in Figure 2.

Figure 2: Fama-French Three-Factor Model Results

	Coefficient	*t-Statistic*
Alpha (α)	0.65%	1.96
Market beta ($\beta_{i,MKT}$)	0.67	8.94
SMB beta ($\beta_{i,SMB}$)	–0.50	–4.92
HML beta ($\beta_{i,HML}$)	0.38	3.52
Adjusted R^2	0.27	

The results in Figure 2 show several interesting aspects. First, the alpha declined slightly but is still very high. Second, the market beta rose from 0.51 to 0.67. Third, the SMB beta is negative, which suggests a large company bias. Fourth, the HML beta is positive, which suggests a value focus for the fund. The adjusted R^2 also rose from 0.14 to 0.27, which suggests that SMB and HML do add value. Based on the results, the custom benchmark implied by the Fama-French three-factor model for Berkshire Hathaway is shown as follows:

R_B = 0.33(T-bills) + 0.67 × (market portfolio)

–0.5(small caps) + 0.5(large caps)

+ 0.38(value stocks) – 0.38(growth stocks)

All of the factor weights in this formula sum to 1.0, but adding the SMB and HML factors add explanatory ability to the regression equation. A test could also be added to account for the **momentum effect**, which is the theory that upward trending stocks will continue their upward movement while downward moving stocks will continue their downward trend. Thus, a fourth factor can be added to the Fama-French model. This fourth factor could be labeled as UMD, which stands for "up minus down" (upward trending stocks minus downward trending stocks). A positive UMD beta would suggest a focus on upward trending stocks, while a negative UMD beta would suggest a focus on downward trending stocks. As with the SMB and HML betas, a beta of zero suggests no relationship. Figure 3 shows the UMD factor added to the previous results. Using this data, it can be discerned that Berkshire Hathaway does not have exposure to momentum investing.

Figure 3: Fama-French Three-Factor Model Results With UMD Factor

	Coefficient	*t-Statistic*
Alpha (α)	0.68%	2.05
Market beta ($\beta_{i,MKT}$)	0.66	8.26
SMB beta ($\beta_{i,SMB}$)	–0.50	–4.86
HML beta ($\beta_{i,HML}$)	0.36	3.33
UMD beta ($\beta_{i,UMD}$)	–0.04	–0.66
Adjusted R^2	0.27	

One core challenge with using the Fama-French model is replication of indices. Fama and French have created an SMB index and an HML index to increase explanatory power, but there is no way to directly trade an SMB or HML portfolio. These indices are conceptual and not directly tradeable. It is important to include only tradeable factors because the factors chosen will greatly influence the calculated alpha.

Measurement of Time-Varying Factors

LO 64.6: Explain how to measure time-varying factor exposures and their use in style analysis.

Style analysis is a form of factor benchmarking where the factor exposures evolve over time. To illustrate time-varying factors, consider four investments: (1) LSV Value Equity (LSVEX), (2) Fidelity Magellan (FMAGX), (3) Goldman Sachs Capital Growth (GSCGX), and (4) Berkshire Hathaway (BRK). Figure 4 shows the regression data from monthly returns on all four funds using the Fama-French three-factor model plus the UMD factor. The key difference between this information and data already presented is that the time period has been adjusted to January 2001 through December 2011.

Figure 4: Regression of Excess Returns for Multiple Funds

	LSVEX	*FMAGX*	*GSCGX*	*BRK*
Alpha (α)	0.00%	–0.27%	–0.14%	0.22%
t-stat	0.01	–2.23	–1.33	0.57
Market beta ($\beta_{i,MKT}$)	0.94	1.12	1.04	0.36
t-stat	36.9	38.6	42.2	3.77
SMB beta ($\beta_{i,SMB}$)	0.01	–0.07	–0.12	–0.15
t-stat	0.21	–1.44	–3.05	–0.97
HML beta ($\beta_{i,HML}$)	0.51	–0.05	–0.17	0.34
t-stat	14.6	–1.36	–4.95	2.57
UMD beta ($\beta_{i,UMD}$)	0.2	0.02	0.00	–0.06
t-stat	1.07	1.00	–0.17	–0.77

This data presents a different story about these funds than earlier. The only calculated alpha that is statistically significant is for Fidelity Magellan, but it is a –3.24% (= –0.27% × 12) in annualized terms. This was not good news for Fidelity investors, although it is time

constrained to a period that ended in 2011. Berkshire's alpha is nicely positive, but for this time period, it is not significant. According to the HML beta factors, LSV Value Equity is indeed a value-focused investment. The data also shows that FMAGX is a leveraged play on the market with a 1.12 market beta. The UMD beta confirms that none of these four funds are momentum plays.

Style analysis tries to solve some of the problems with standard multifactor regression. Unlike Fama and French's untradeable SMB and HML indices, style analysis uses tradeable assets. For example, consider three funds: (1) SPDR S&P 500 ETF (SPY), (2) SPDR S&P 500 Value ETF (SPYV), and (3) SPDR S&P 500 Growth ETF (SPYG). These three exchange-traded funds (ETFs) are hosted by State Street Global Advisors and they all belong to the SPDR (pronounced "spider") family of ETFs. Style analysis also adjusts for the fact that factor loadings (betas) change over time. A possible multifactor regression could be estimated for next period's expected asset return (R_{t+1}) as follows:

$$R_{t+1} = \alpha_t + \beta_{SPY,t}SPY_{t+1} + \beta_{SPYV,t}SPYV_{t+1} + \beta_{SPYG,t}SPYG_{t+1} + \varepsilon_{t+1}$$

This formula has an imposed restriction that all factor loadings (i.e., factor weights) must sum to one:

$$1 = \beta_{SPY,t} + \beta_{SPYV,t} + \beta_{SPYG,t}$$

The time-varying portion of this equation comes into play with the respective factor loadings. This process uses estimates that incorporate information up to time *t*. Every new month (t + 1) requires a new regression to adjust the factor loadings. This means that the beta factors will change over time to reflect changes in the real world.

Issues with Alpha Measurement for Nonlinear Strategies

LO 64.7: Describe issues that arise when measuring alphas for nonlinear strategies.

Alpha is computed using regression, which operates in a linear framework. There are nonlinear strategies, such as uncovered long put options, that can make it appear that alpha exists when it actually does not. An uncovered long put option has a payoff profile that is L-shaped (nonlinear), but applying traditional regression tools will yield a positive alpha, which does not exist in reality. This situation is encountered when payoffs are quadratic terms, like R_t^2 or are option-like terms, such as $\max(R_t, 0)$. This can be a significant problem for hedge funds, because merger arbitrage, pairs trading, and convertible bond arbitrage strategies all have nonlinear payoffs.

One reason that nonlinear strategies yield a false positive alpha is because the distribution of returns is not a normal distribution. Certain nonlinear strategies will also exhibit negative skewness in their distribution. This will increase loss potential in the left-hand tail and make the middle of the distribution appear thicker. Skewness is not factored into the calculation of alpha, which is an issue for nonlinear payoff strategies.

Volatility and Beta Anomalies

LO 64.8: Compare the volatility anomaly and beta anomaly, and analyze evidence of each anomaly.

Using data from 1926–1971, Haugen and Heins (1975)[3] found that "over the long run, stock portfolios with lesser variance in monthly returns have experienced greater average returns than 'riskier' counterparts." Ang, Hodrick, Xing, and Zhang (2006)[4] tested whether increased volatility, as measured by standard deviation, has a positive relationship with returns and Sharpe ratios. They organized their data, which comprised monthly return data from September 1963–December 2011, into quintiles and controlled for numerous variables including leverage, volume, bid-ask spreads, dispersion in analyst's forecasts, and momentum. They observed a **volatility anomaly** which shows that as standard deviation increased, both the average returns and the Sharpe ratios decreased. For the lowest three quintiles, the average return was above 10%, but declined to 6.8% for quintile 4 and to 0.1% for the quintile with the highest volatility. Likewise, Sharpe ratios declined from 0.8 for the lowest volatility quintile to 0.0 for the highest volatility quintile. It was found that the most volatile stocks produce the lower returns, while the least volatile stocks performed the best.

When the capital asset pricing model (CAPM) was first tested in the 1970s, a positive relationship was found between beta and expected returns. Numerous academics have since retested this relationship with interesting results. Ang et al. (2006) found that stocks with high betas tend to have lower-risk-adjusted returns. Organizing monthly return data from September 1963–December 2011 into quintiles, they found that the Sharpe ratio fell from 0.9 for stocks with the lowest betas to 0.4 for stocks with the highest betas. This **beta anomaly** does not suggest that stocks with higher betas have low return because they do not. It means they have lower Sharpe ratios (risk-adjusted performance) because higher betas are paired with higher volatility as measured by standard deviation, which is the denominator in the Sharpe ratio.

Interestingly, CAPM does *not* predict that lagged betas (measured over previous periods) should produce higher returns. It does predict that investors should find a contemporaneous relationship between beta and expected returns. This means that stocks with higher betas should also have higher returns during the same time period when the beta was measured. This is a confirming, not a predictive, metric. Following this logic, if investors could reliably predict future betas, then they could more accurately predict future expected returns. The trouble is that historical betas are not good predictors of future betas. Buss and Vilkov (2012)[5] estimated future betas using implied volatility measures in option pricing models and found some improvement over using historical betas. The beta anomaly is less a mystery as it is a challenge to find a reliable way of predicting future betas to improve the risk perspective of beta.

3. Robert A. Haugen and A. James Heins, "Risk and the Rate of Return on Financial Assets: Some Old Wine in New Bottles," *Journal of Financial and Quantitative Analysis* 10, no. 5 (1975): 775–84.
4. Andrew Ang, Robert J. Hodrick, Yuhang Xing, and Xiaoyan Zhang, "High Idiosyncratic Volatility and Low Returns: International and Further U.S. Evidence," *Journal of Financial Economics* 91 (2009): 1–23.
5. Adrian Buss and Grigory Vilkov, "Measuring Equity Risk With Option-Implied Correlations," *The Review of Financial Studies* 25, no. 10 (2012): 3113–40.

Potential Explanations for the Risk Anomaly

LO 64.9: Describe potential explanations for the risk anomaly.

A comprehensive explanation for the risk anomaly is elusive. It has been speculated that the true explanation is some combination of data mining, investor leverage constraints, institutional manager constraints, and preference theory.

Some academics have wondered if the risk anomaly is the result of *data mining*. Ang et al. (2006) found that the risk anomaly appears during both recessions and expansions. Frazzini and Pedersen (2014)[6] found that low beta portfolios have high Sharpe ratios in U.S. stocks, international stocks, Treasury bonds, and corporate bonds. Cao and Han (2013)[7] also found evidence of the risk anomaly in option and commodity markets. The argument of data mining is not well supported.

Another possible explanation is the prevalence of *leverage constrained investors*. This is sometimes an occurrence with institutional investors, but it is very much a constraint of retail investors. Since certain investors are leverage constrained, meaning that they cannot borrow funds for investing, they choose to invest in stocks with built-in leverage in the form of high betas. The additional demand for high-beta stocks will bid up their respective prices until the assets are overvalued and they deliver a decreased risk-adjusted return with regard to lower beta stocks. This same theory works to lower the prices of low beta stocks and, therefore, results in higher risk-adjusted returns due to lower entry prices.

Institutional managers also have *constraints* that could help to explain the risk anomaly. Consider a scenario with two competing portfolios. Portfolio A has positive alpha because the portfolio is undervalued, while Portfolio B has a negative alpha because it is overvalued. In a perfect world, an investor would buy (go long) Portfolio A and short sell Portfolio B to capture the perceived alphas. Many institutional investors will have constraints against short selling. Most also have tracking error constraints that only permit a specified deviation from their benchmark. Under either of these constraints, an institutional investor would not be able to capture the alpha that they think exists. One solution for the tracking error constraint is to change the benchmark or the tracking error tolerance bands, but this can be a difficult process requiring formal approval from the investment committee of the fund.

Sometimes investors simply have a *preference* for high-volatility and high-beta stocks. This could occur because their capital market expectations are very bullish, so they want to amplify their returns. The end result is that investors buy the higher-beta investments and bid up their prices to the point where future returns will be much lower. There will always be a group of investors that desire to shun "safe" and "boring" lower-volatility stocks. The good news is that this creates less emotionally driven entry points for long-term investors who desire lower volatility.

6. Andrea Frazzini and Lasse Heje Pederson, "Betting Against Beta," *The Journal of Financial Economics* 111, no. 1 (2014): 1–25.
7. Jie Cao and Bing Han, "Cross Section of Option Returns and Idiosyncratic Stock Volatility," *The Journal of Financial Economics* 108, no. 1 (2013): 231–49.

Investors holding heterogeneous preferences (disagreeing on investment potential) and having investment constraints could explain a portion of the risk anomaly. Hong and Sraer (2012)[8] found that when disagreement is low and investors are long-only constrained, then the CAPM holds the best. When disagreement is high, some investments become overpriced and future returns are decreased. Significant disagreement can lead to an inverse relationship between beta and returns.

8. Harrison Hong and David Sraer, "Speculative Betas," NBER Working Paper 18548, November 2012.

Key Concepts

LO 64.1

The capital asset pricing model (CAPM) states that there should be a positive relationship between risk and return. Higher risk, as measured by beta, should have a higher return. The low-risk anomaly appears to suggest the exact opposite. This anomaly finds that firms with lower betas and lower volatility have higher returns over time.

LO 64.2

Alpha is the average performance of an investor in excess of their benchmark. Excess return is often called active return, and the standard deviation of the active return is known as tracking error.

The ratio of active return to tracking error is called the information ratio, which is one way to easily rank competing investment alternatives.

$$\text{IR} = \frac{\alpha}{\bar{\sigma}}$$

If an investor is using the risk-free rate as their benchmark, then their alpha is any return earned in excess of the risk-free rate, and the best risk-adjusted return measurement is the Sharpe ratio.

$$\text{Sharpe ratio} = \frac{\bar{R}_t - \bar{R}_F}{\sigma}$$

LO 64.3

A benchmark is very important for investment comparisons. If the benchmark is riskier than the investment in question, then both the alpha and the information ratio will be too low. The best combination for a benchmark is for it to be well-defined, tradeable, replicable, and adjusted for the risk of the underlying pool of investments.

LO 64.4

Grinold's fundamental law of active management suggests a tradeoff between the number of investment bets placed (breadth) and the required degree of forecasting accuracy (information coefficient).

$$\text{IR} \approx \text{IC} \times \sqrt{\text{BR}}$$

An investor either needs to place a large number of bets and not be very concerned with forecasting accuracy, or he needs to be very good at forecasting if he places only a small number of bets.

LO 64.5

The traditional capital asset pricing model only accounts for co-movement with a market index. Multifactor models, like the Fama and French three-factor model, add other explanatory factors in an attempt to better predict the alpha for an asset. Multifactor models have been shown to enhance the informational value of regression output. The Fama-French three-factor model is expressed as:

$$R_i - R_F = \alpha + \beta_{i,MKT} \times (R_M - R_F) + \beta_{i,SMB} \times (SMB) + \beta_{i,HML} \times (HML)$$

This model adds a size premium (SMB) and a value premium (HML) to the CAPM single-factor model. A momentum effect (UMD) could also be added to help explain excess returns. This factor suggests that upward trending stocks will continue their upward movement while downward moving stocks will continue their downward trend.

LO 64.6

Style analysis is a form of factor benchmarking where the factor exposures evolve over time. The traditional Fama-French three-factor model can be improved by using indices that are tradeable, such as the SPDR S&P Value ETF (SPYV), and incorporating time-varying factors that change over time.

LO 64.7

Alpha is computed using regression, which operates in a linear framework. There are nonlinear strategies that can make it appear that alpha exists when it actually does not. This situation is encountered when payoffs are quadratic terms or option-like terms. This may be a significant problem for hedge funds because merger arbitrage, pairs trading, and convertible bond arbitrage strategies all have nonlinear payoffs.

LO 64.8

The volatility anomaly and the beta anomaly both agree that stocks with higher risk, as measured by either high standard deviation or high beta, produce lower risk-adjusted returns than stocks with lower risk.

LO 64.9

A comprehensive explanation for the risk anomaly is elusive. It has been speculated that the true explanation is some combination of data mining, investor leverage constraints, institutional manager constraints, and preference theory.

Concept Checkers

1. Which of the following statements is correct concerning the relationship between the low-risk anomaly and the capital asset pricing model (CAPM)?
   A. The low-risk anomaly provides support for the CAPM.
   B. The notion that the low-risk anomaly violates the CAPM has not been proven empirically.
   C. The low-risk anomaly violates the CAPM and suggests that low-beta stocks will outperform high-beta stocks.
   D. Both CAPM and the low-risk anomaly point to a positive relationship between risk and reward.

2. Which of the following statements is not a characteristic of an appropriate benchmark? An appropriate benchmark should be:
   A. tradeable.
   B. replicable.
   C. well-defined.
   D. equally applied to all risky assets irrespective of their risk exposure.

3. Grinold's fundamental law of active management suggests that:
   A. investors should focus on increasing only their predictive ability relative to stock price movements.
   B. sector allocation is the most important factor in active management.
   C. a small number of investment bets decreases the chances of making a mistake and, therefore, increases the expected investment performance.
   D. to maximize the information ratio, active investors need to either have high-quality predictions or place a large number of investment bets in a given year.

4. Why would an investor include multiple factors in a regression study?
   I. To attempt to improve the adjusted R^2 measure.
   II. To reduce the *t*-stat value on the respective regression coefficients.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

5. Which of the following characteristics is a potential explanation for the risk anomaly?
   A. Investor preferences.
   B. The presence of highly leveraged retail investors.
   C. Lack of short selling constraints for institutional investors.
   D. Lack of tracking error constraints for institutional investors.

Concept Checker Answers

1. **C** The low-risk anomaly violates the CAPM and suggests that low beta stocks will outperform high-beta stocks. This has been empirically proven with several studies. The CAPM points to a positive relationship between risk and reward, but the low-risk anomaly suggests an inverse relationship.

2. **D** An appropriate benchmark should be well-defined, replicable, tradeable, and risk-adjusted. If the benchmark is not on the same risk scale as the assets under review, then there is an unfair comparison.

3. **D** Grinold's fundamental law of active management focuses on the tradeoff of high quality predictions relative to placing a large number of investment bets. Investors can focus on either action to maximize their information ratio, which is a measure of risk-adjusted performance. While sector allocation is a very important component of the asset allocation decision, Grinold focused only on the quality of predictions and the number of investment bets made.

4. **A** An investor should consider adding multiple factors to the regression analysis to potentially *improve* the adjusted R^2 measurement, potentially *increase* the tests of statistical significance, and to search for a benchmark that is more representative of a portfolio's investment style.

5. **A** Potential explanations for the risk anomaly include: the preferences of investors, leverage constraints on retail investors that drive them to buy pre-leveraged investments in the form of high-beta stocks, and institutional investor constraints like prohibitions against short selling and tracking error tolerance bands.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Illiquid Assets

Topic 65

Exam Focus

This topic examines illiquid asset market characteristics and the relationship between illiquidity and market imperfections. Reported return biases are discussed as well as the illiquidity risk premium within and across asset classes. For the exam, understand that all markets, even highly liquid markets such as commercial paper, can be illiquid at some points in time. Also, know the three biases that impact reported returns of illiquid asset classes (survivorship bias, sample selection bias, and infrequent sampling). Finally, understand the factors that influence the decision to include illiquid asset classes in a portfolio.

Illiquid Asset Markets

LO 65.1: Evaluate the characteristics of illiquid markets.

There are several characteristics that describe illiquid asset markets, including:

1. Most asset classes are illiquid, at least to some degree.
2. Markets for illiquid assets are large.
3. Illiquid assets comprise the bulk of most investors' portfolios.
4. Liquidity dries up even in liquid asset markets.

Most Asset Classes Are Illiquid

All markets, even large-cap equity markets, are somewhat illiquid. It is clear, however, that some assets (e.g., real estate) are less liquid than others (e.g., public equities). Illiquid assets trade infrequently, in small amounts, and generally exhibit low turnover. For example, there are mere seconds between transactions in public equity markets with an annualized turnover rate greater than 100%. In contrast, over-the-counter (OTC) equities typically trade within a day, but sometimes a week or more may pass between trades, with annualized turnover of 25% to 35%. Corporate bonds trade daily, and municipal bonds typically trade semiannually. At the far end of the liquidity spectrum is institutional infrastructure with an average investment commitment of 50 to 60 years (up to 99 years), and art, with 40 to 70 years between transactions. There is negligible turnover in infrastructure. Turnover in residential real estate is about 5% per year, while turnover in institutional real estate is approximately 7%. Time between real estate transactions can range from months to decades.

Markets for Illiquid Assets Are Large

The size of the U.S. residential mortgage market was $16 trillion in 2012. The institutional real estate market was measured at $9 trillion. In contrast, the market capitalization of the NYSE and Nasdaq combined was approximately $17 trillion. The total wealth held in illiquid assets exceeds the total wealth in traditional, liquid stock, and bond markets.

Investor Holdings of Illiquid Assets

The home is often an individual's most valuable asset. As a result, illiquid assets represent approximately 90% of total wealth, not counting human capital, the largest and least liquid asset for many individual investors. High net worth individuals in the United States even typically allocate 10% of portfolios to fine art and jewelry, known as treasure assets. High net worth individuals in foreign countries hold an average of 20% in treasure assets. Institutional investors have also increased allocations to illiquid assets over the last 20 years. University endowments have increased allocations of illiquid assets to approximately 25%, up from 5% in the early 1990s. Pension funds have increased allocations to approximately 20%, up from 5% in 1995. In general, investors hold sizeable amounts of illiquid assets.

Liquidity Can Dry Up

In stressed economic periods, such as during the 2007–2009 financial crisis, liquidity can dry up. For example, money markets froze (i.e., repurchase agreement and commercial paper markets) during the crisis as investors were unwilling to trade at any price. Residential and commercial mortgage-backed securities markets, structured credit markets, and the auction rate securities market, a market for floating rate municipal bonds, also became illiquid during the crisis. The auction rate securities market is still frozen, more than six years later. Major liquidity crises have occurred at least once every 10 years across the globe, in conjunction with downturns and financial distress.

Market Imperfections

LO 65.2: Examine the relationship between market imperfections and illiquidity.

Many economic theories assume that markets are perfect. This means that market participants are rational and pursue utility maximization, that there are no transaction costs, regulation or taxes, that assets are perfectly divisible, that there is perfect competition in markets, and that all market participants receive information simultaneously. The reality, though, is that markets are imperfect.

Imperfections that encourage illiquidity include:

- **Market participation costs.** There are costs associated with entering markets, including the time, money, and energy required to understand a new market. In many illiquid markets, only certain types of investors have the expertise, capital, and experience to participate. This is called a **clientele effect**. There will be less liquidity in markets that are suited to a limited number of investors and/or where there are barriers to entry in terms of required experience, capital, or expertise.

- **Transaction costs.** Transaction costs include taxes and commissions. For many illiquid assets, like private equity, there are additional costs, including costs associated with performing due diligence. Investors must pay attorneys, accountants, and investment bankers. These costs can impede investment.

When acknowledging the existence of transaction costs (i.e., acknowledging that markets are imperfect), some academic studies assume that as long as an investor can pay the transaction costs (and sometimes these costs are large), then any investor can transact (i.e., any asset can be liquid if one can pay the transaction cost). However, this is not always true. For example, there are:

- **Difficulties finding a counterparty (i.e., search frictions).** For example, it may be difficult to find someone to understand/purchase a complicated structured credit product. It may also be difficult to find buyers with sufficient capital to purchase an office tower or a skyscraper in a city like New York. No matter how high the transaction cost, it may take weeks, months, or years to transact in some situations.
- **Asymmetric information.** Some investors have more information than others. If an investor fears that the counterparty knows more than he does, he will be less willing to trade, which increasing illiquidity. When asymmetric information is extreme, people assume all products are lemons. Because no one wants to buy a lemon, markets break down. Often liquidity freezes are the result of asymmetric information. Because investors are looking for non-predatory counterparties who are not seeking to take advantage of asymmetric information, information itself can be a form of search friction.
- **Price impacts.** Large trades can move markets, which, in turn, can result in liquidity issues for the asset or asset class.
- **Funding constraints.** Many illiquid assets are financed largely with debt. For example, even at the individual level, housing purchases are highly leveraged. As a result, if access to credit is compromised, investors cannot transact.

Illiquid Asset Return Biases

LO 65.3: Assess the impact of biases on reported returns for illiquid assets.

LO 65.4: Describe the unsmoothing of returns and its properties.

In general, investors should be skeptical of reported returns in illiquid asset markets. The reason is that reported returns are generally overstated. There are reporting biases that result in inflated returns. Three main biases that impact returns of illiquid assets are:

- Survivorship bias.
- Selection bias.
- Infrequent trading.

Survivorship Bias

There are no requirements for certain types of funds (e.g., private equity, hedge funds, buyout funds, and so on) to report returns to database providers. As such, poorly performing funds have a tendency to stop reporting. Additionally, funds may never begin reporting because returns are not high enough to appeal to investors. This results in **reporting biases**. In addition, many poorly performing funds ultimately fail. Performance studies generally include only those funds that were successful enough to survive over the entire period of

analysis, leaving out the returns of funds that no longer exist. Both of these factors result in reported returns that are too high. This is called **survivorship bias**. Non-surviving funds have below average returns and surviving funds have above average returns, but it is the surviving fund returns that are reported. Studies show mutual fund returns are 1% to 2% lower than reported and returns may be as much as 4% lower for illiquid asset markets. While the solution to survivorship bias seems obvious (to observe the entire universe of funds), it is impossible to do in illiquid asset markets.

Sample Selection Bias

Asset values and returns tend to be reported when they are high. For example, houses and office buildings typically are sold when values are high. Often, a seller will wait until property values recover before selling. These higher selling prices are then used to calculate returns. This results in **sample selection bias**.

The problem with selection bias is especially prevalent in private equity markets. Buyout funds take companies public when stock prices are high. Venture capitalists sell companies when values are high. Distressed companies are often not liquidated and left as shell companies (these are sometimes called zombie companies). It is difficult to tell, based on old data without any recent transactions, if a company is alive or whether it is a zombie.

Impacts of sample selection bias include:

- Higher reported alphas relative to true alphas because only high prices are recorded. For example, one study estimates an alpha of more than 90% for venture capital log returns. However, alpha falls to –7% after correcting for sample selection bias. Another study estimates returns are decreased 2% to 5% per month if you correct for the bias.
- Lower reported betas than true betas because there are fewer (only high) prices recorded, flattening the security market line (SML). The effect is smaller for real estate returns because volatility is lower than in private equity and studies often include downturns such as what happened in real estate in the early 1990s and the early 2000s.
- Lower reported variance of returns than the true variance of returns because only high returns are counted (i.e., underestimated risk).

In sum, sample selection bias results in overestimated expected returns and underestimated risk as measured by beta and the standard deviation of returns (i.e., volatility).

Infrequent Trading

Illiquid assets, by definition, trade infrequently. **Infrequent trading** results in underestimated risk. Betas, return volatilities, and correlations are too low when they are computed using the reported returns of infrequently traded assets. Returns for these infrequently traded assets are smoothed. For example, if one compares quarterly returns to the daily returns of the same asset, quarterly returns will appear (and actually be) less volatile. Prices will often be higher or lower in a given investment horizon, than it appears when examining quarterly returns. The computed standard deviation of returns often will be lower when examining quarterly returns compared to daily returns. Also, correlations with other asset classes (e.g., liquid assets such as large-cap stocks) will be artificially low because return volatility is muted by infrequent trades.

It is possible to unsmooth or de-smooth returns using **filtering algorithms**. Filtering algorithms generally remove noise from signals. However, unsmoothing adds noise back to reported returns to uncover the true, noisier returns. Unsmoothing returns affects risk and return estimates, and could have a dramatic effect on returns. For example, reported real estate returns during the 1990s downturn were –5.3%. The corresponding unsmoothed returns were –22.6%. The National Council of Real Estate Investment Fiduciaries (NCREIF) returns reached –8.3% in December 2008. Unsmoothed returns during the same quarter were –36.3%. The standard deviation of the raw returns was 2.25% during the same quarter compared to 6.26% for unsmoothed returns. For comparison, stock return volatility was approximately 7.5% per quarter. Correlations between the S&P 500 Index and NCREIF returns increased from 9.2% to 15.8% when returns were unsmoothed.

Illiquidity Risk Premiums

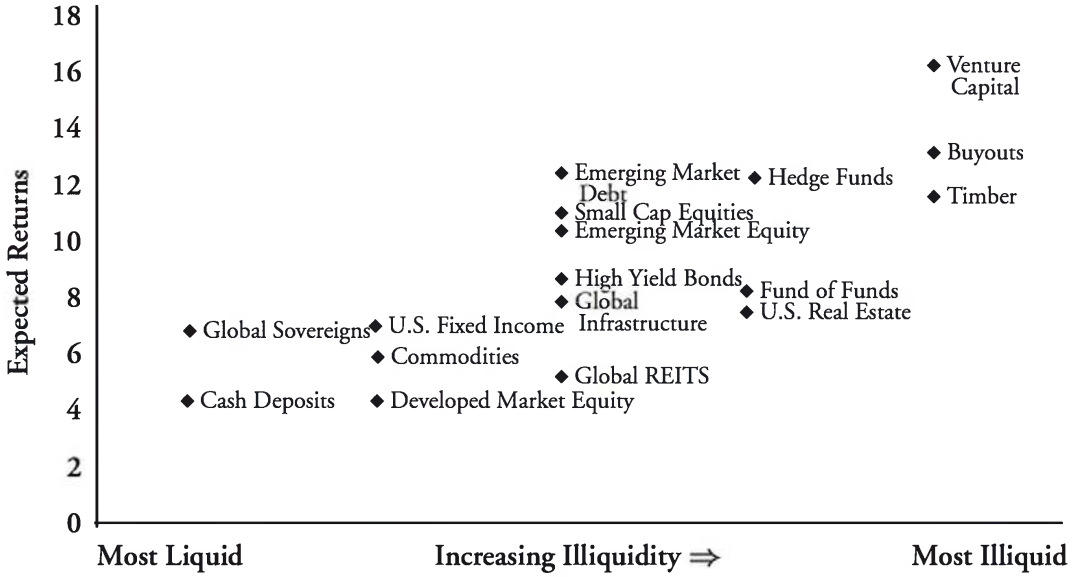
LO 65.5: Compare illiquidity risk premiums across and within asset categories.

Illiquidity Risk Premiums Across Asset Classes

As part of the analysis in Antti Ilmanen's 2011 book *Expected Returns*[1], we can relate liquidity to expected returns as shown in Figure 1. Note, however, that we cannot completely pigeonhole asset classes based on illiquidity (e.g., some private equity funds are more liquid than some hedge funds or infrastructure investments). Also note that, in this analysis, returns are computed over the period 1990 to 2009 and the illiquidity estimates are just estimates (i.e., they represent Ilmanen's opinions). Ilmanen's work does imply a positive relationship between the illiquidity of an asset class and its expected return. Venture capital is considered the least liquid and has the highest expected return, between 16% and 17%. Buyout funds and timber are also illiquid but command lower expected returns, approximately 13% and close to 12%, respectively. Hedge funds are more liquid and are expected to earn a little more than 12%. Real estate is on par with hedge funds in terms of liquidity but commands a lower return of nearly 8%. Equities are much more liquid and earned a bit more than 4% over the period. Cash is the most liquid and it too earned a little over 4% during the period.

1. Ilmanen, A. (2011). *Expected Returns: An Investor's Guide to Harvesting Market Rewards*. Chichester, West Sussex, U.K.: Wiley.

Figure 1: Liquidity vs. Expected Returns



It is the conventional view that there is a premium for illiquidity. However, this may not be true. First, there are illiquidity biases. As discussed previously, reported returns of illiquid assets are too high (i.e., overstated if using raw, unsmoothed data) and risk and correlation estimates are too low.

Second, illiquid asset classes such as private equity, buyout funds, and physical assets like timber contain significant risks beyond liquidity risk. After adjusting for these risks, illiquid asset classes are much less attractive. According to one study, after adjusting for risk, most investors are better off investing in the S&P 500 than in a portfolio of private equity.

Third, there is no "market index" for illiquid assets. Private equity, hedge fund, and real estate indices are not investable, so no investor is actually earning the index return. For example, the NCREIF includes thousands of properties. Because individuals do not typically own thousands of properties, they are much more subject to idiosyncratic risks and are less diversified within the asset class.

Fourth, you must rely on manager skill in illiquid asset classes. There is no way, as there is with tradeable, cheap bond and equity index funds, to separate factor risk (i.e., systematic risk) from the talents of fund managers. As noted, there is no way to earn index returns. If an investor cannot earn index returns in illiquid asset class markets, he has no way of separating passive returns from alpha generated by active managers.

These factors imply that it may not be possible to generate substantial illiquidity risk premiums across illiquid asset classes. However, there is evidence of large illiquidity risk premiums within asset classes.

Illiquidity Risk Premiums Within Asset Classes

Less liquid assets generally have higher returns than more liquid assets, within asset classes. Currently, there is no formal theory about why illiquidity risk premiums exist within asset

classes but not between. It might be that investors simply overpay for illiquid asset classes, chasing the illusion of higher returns. It may also be that firms do not manage portfolios as a cohesive whole, but instead put asset classes in different silos. Mispricing (i.e., the lack of a premium across classes) may be due to slow-moving capital across classes, limits to arbitrage, and institutional constraints (e.g., the fixed-income desk doesn't talk to the equity traders, and so on).

Illiquidity Effects in U.S. Treasury Markets

On-the-run (i.e., newly issued) Treasury bills (T-bills) are more liquid and have lower yields than off-the-run (seasoned) T-bills. The difference is called the on-the-run/off-the-run bond spread. During the 2007–2009 financial crisis, same maturity T-bonds and T-notes traded with different yields. While prices should have been the same, T-bond prices were more than 5% lower than T-note prices. Given that the U.S. Treasury market is one of the largest and most liquid in the world, it is surprising to observe large illiquidity effects.

Illiquidity Effects in Corporate Bond Markets

Larger bid-ask spreads and infrequent trading led to higher yields in corporate bond markets. Studies indicate that illiquidity risk explains 7% of the variation in investment grade bond yields and 22% of the variation in junk bond yields. Also, as bid-ask spreads increase, yield spreads increase by more than double the amount (e.g., a one-basis point increase in the bid-ask spread results in a more than two-basis point increase in the yield spread).

Illiquidity Effects in Equity Markets

There are several variables related to illiquidity that are shown to impact equity returns. Studies indicate that less liquid stocks earn higher returns than more liquid stocks. Illiquidity factors that impact equity returns are:

- Bid-ask spreads.
- Volume.
- Turnover.
- Volume measured by whether the trade was initiated by buyers or sellers.
- Ratio of absolute returns to dollar volume, called the "Amihud measure."
- Price impact of large trades.
- Informed trading measures (i.e., adverse selection).
- Quote size.
- Quote depth.
- Frequency of trades.
- Number of "zero" returns (in liquid markets returns are usually not zero).
- Return autocorrelations (which are a measure of stale prices).

All of these factors are characteristics of illiquidity that are unique to each stock. There are also illiquidity risk betas that are covariances of stock returns with illiquidity factors. Researchers estimate illiquidity risk premiums at 1% to 8% depending on the illiquidity measure used. Research also indicates that risk premiums have declined, although studies find a 1% risk premium for listed equities compared to a 20% risk premium for OTC stocks.

Secondary Markets for Private Equity and Hedge Funds

Private equity funds trade companies with each other, providing needed liquidity. In 2005, these secondary buyouts represented about 15% of all private-equity buyout deals. This does allow funds to get out of specific deals, may give limited partners (LPs) some cash in the process, and may allow LPs to better understand the values of portfolio companies. However, secondary buyouts do not allow limited partners to get out of the private equity fund itself.

LPs can exit private equity funds in secondary markets. However, these markets are immature, small, and more opaque. Firms participating in these markets on the buy side were called vultures in the 1990s. Buyers took advantage of distressed sellers, getting discounts of 30% to 50%. Discounts fell below 20% in the early 2000s, but shot up again during the 2007–2009 financial crisis.

Harvard University saw its endowment fall by more than $8 billion, or 22%, between July 1, 2008, and October 31, 2008. Harvard relies on the endowment for some of its operating funds. Endowment fund managers attempted to sell stakes in private equity to free up cash for operations and faced discounts of 50%.

Because hedge fund investors can typically redeem their investments at predetermined dates, discounts on secondary market transactions are much smaller than in private equity investments. During the recent financial crisis, hedge fund discounts were 6% to 8% on average. Some funds traded at a premium, even during the crisis, due to strong demand (i.e., the funds were closed to new investors). Large asset owners like sovereign funds and pension funds can supply liquidity in hedge fund and private equity markets, buying stakes at reduced prices and harvesting illiquidity risk premiums.

In sum, there are four ways that investors can harvest illiquidity premiums:

1. Allocating a portion of the portfolio to illiquid asset classes like real estate. This is **passive allocation to illiquid asset classes**.

2. Choosing more illiquid assets within an asset class. This means engaging in **liquidity security selection**.

3. Acting as a **market maker** for individual securities. For example, Dimensional Funds Advisors (DFA) is a liquidity provider that buys stock at a discount from those wanting to sell quickly and sells small-cap stocks at a premium to investors demanding shares. The firm avoids adverse selection problems by choosing counterparties who fully disclose information about stocks. The firm is trustworthy in its dealings and does not manipulate prices or engage in front running. Sovereign wealth funds, large pension funds, and other large asset owners can also act as market makers, providing liquidity while buying at discounts and selling at premiums.

4. Engaging in **dynamic factor strategies** at the aggregate portfolio level. This means taking long positions in illiquid assets and short positions in liquid assets to harvest the illiquidity risk premium. Investors rebalance to take advantage of the liquidity differences as less liquid assets become more liquid. Rebalancing the portfolio is the simplest way to provide liquidity. As long as buyers buy when others want to sell and sell when others want to buy, rebalancing is countercyclical. Of the four ways investors can harvest the illiquidity premium, this is the easiest to implement and can have the greatest effect on portfolio returns.

Portfolio Allocation to Illiquid Assets

LO 65.6: Evaluate portfolio choice decisions on the inclusion of illiquid assets.

In determining the portfolio allocation to illiquid asset classes, or any asset class for that matter, investors must consider their personal circumstances. The illiquid asset allocation decision is influenced by different investment horizons, the lack of tradeable indices, the need to hire talented active portfolio managers, and the need to monitor those managers. Portfolio choice models that include illiquid assets must consider two important aspects of illiquidity that impact investors:

1. Long time horizons between trades (i.e., infrequent trading).

2. Large transaction costs.

Asset Allocation to Illiquid Asset Classes with Transaction Costs

The primary issue with asset allocation models that include transaction costs is that they assume an asset will always trade if the counterparty pays the transaction cost. However, this is not true in private equity, infrastructure, real estate, and timber markets. It is not (or may not) be possible to find a buyer in a short period of time. Counterparties, if identified, must perform due diligence, which takes time. In some cases, the counterparty, upon completion of due diligence, chooses not to buy the asset. In periods of stress, even liquid asset classes face liquidity freezes and it becomes impossible to find buyers at any price.

Asset Allocation to Illiquid Asset Classes with Infrequent Trading

As anyone trying to sell in a period of illiquidity knows, one cannot "eat" illiquid assets. Consider the example of Harvard University, briefly described earlier. The only way the university could generate cash for operations in a period of significant losses and illiquidity across what some would consider some of the most liquid assets (i.e., commercial paper and repurchase agreements), Harvard would have had to sell at huge discounts. Only liquid assets can be consumed. As a result, illiquidity has a major effect on investors' portfolio choices. Illiquidity causes the following with respect to portfolio choice:

- **Reduces optimal holdings**. The less frequently a liquidity event is expected to occur, the lower the allocation to the illiquid asset class.
- Rebalancing illiquid assets (i.e., when there is infrequent trading in the asset class) causes allocations to **vary significantly**. The investor must wait until the liquidity event arrives. As such, the allocation prior to a liquidity event (or during nonrebalancing periods) can vary from too high to too low relative to the optimal allocation.

- Investors cannot hedge against declining values when an asset cannot be traded. As a result, **illiquid asset investors must consume less** than liquid asset investors to offset the risk.
- **There are no illiquidity "arbitrages."** To construct an arbitrage, an asset must be continuously traded. Illiquid assets are not continuously traded.
- Due to infrequent trading, illiquid asset investors must **demand an illiquidity risk premium**. The more frequently the asset is traded, the lower the premium. For example, one study indicates that private equity investments generate returns 6% higher than public markets to compensate investors for illiquidity.

The inclusion of illiquid assets in a portfolio is not as simple or desirable as it might seem. The following points should be considered:

1. Studies show that illiquid assets do not deliver higher risk-adjusted returns.

2. Investors are subject to agency problems because one must rely on the talents and skills of the manager. It is difficult to monitor external managers (e.g., private equity managers).

3. In many firms, illiquid assets are managed separately from the rest of the portfolio.

4. Illiquid asset investors face high idiosyncratic risks. There is no "market" portfolio of illiquid assets. Recall the example of the NCREIF versus the individual investor. It is not possible for most investors to hold thousands of properties, and small numbers of properties can lead to undiversified, property specific risks (but also returns, making illiquid assets compelling to investors). Illiquid assets are compelling because:
   - Illiquid asset markets are less efficient than stock and bond markets.
   - There are large information asymmetries in illiquid asset markets.
   - High transaction costs keep many investors out of the market.
   - Management skill is crucial and alpha opportunities are widely dispersed.

   All of these factors suggest there are great opportunities for the skilled investor to profit from investments in illiquid assets. Investors must have the skills and resources to find, evaluate, and monitor illiquid asset opportunities. Endowments like Harvard, Yale, and Stanford have the skills and resources. Unskilled investors, even those endowments at less sophisticated, skilled, and connected schools, can lose big in illiquid asset markets.

Key Concepts

LO 65.1

There are four main characteristics that describe illiquid asset markets, including:

1. Most asset classes are illiquid, at least to some degree.

2. Markets for illiquid assets are large.

3. Illiquid assets comprise the bulk of most investors' portfolios.

4. Liquidity dries up even in liquid asset markets.

LO 65.2

Market imperfections encourage illiquidity in asset markets. Specifically, market participation costs (i.e., clientele effects) and transaction costs give rise to illiquidity. Some academic models assume that all assets can be traded if one will pay the required (sometimes very high) transaction cost. However, this is not necessarily true in illiquid asset markets. There are search frictions (i.e., difficulties finding a counterparty and information asymmetries), price impacts, and funding constraints that may prevent trades from occurring, no matter how high the transaction cost.

LO 65.3

In general, investors should be skeptical of reported returns in illiquid asset markets as they are generally overstated. There are reporting biases that result in artificially inflated returns. The three main biases that impact reported illiquid asset returns are:

1. Survivorship bias: Poor performing funds often quit reporting results. Also, many poor performing funds ultimately fail. Finally, some poor performing funds never begin reporting returns because performance is weak. All of these factors lead to survivorship bias. Survivorship bias leads to an overstatement of stated returns relative to true returns.

2. Selection bias: Asset values and returns tend to be reported when they are high. For example, houses and office buildings typically are sold when values are high. These higher selling prices are used to calculate returns. This results in sample selection bias, which again leads to overstated returns.

3. Infrequent trading: Illiquid assets, by definition, trade infrequently. Infrequent trading results in underestimated risk. Betas, return volatilities, and correlations are too low when they are computed using the reported returns of infrequently traded assets.

LO 65.4

Unsmoothing adds noise back to reported returns to uncover the true, noisier returns. This process affects risk and return estimates and could have a dramatic effect on returns.

LO 65.5

There is little evidence that there are large illiquidity risk premiums across asset classes. However, there are large illiquidity risk premiums within asset classes.

There are four primary ways that investors can harvest illiquidity premiums:

1. Allocating a portion of the portfolio to illiquid asset classes like real estate. This is passive allocation to illiquid asset classes.

2. Choosing more illiquid assets within an asset class. This means engaging in liquidity security selection.

3. Acting as a market maker for individual securities.

4. Engaging in dynamic factor strategies at the aggregate portfolio level. This means taking long positions in illiquid assets and short positions in liquid assets to harvest the illiquidity risk premium. Of the four ways investors can harvest illiquidity premiums, this is the easiest to implement and can have the greatest effect on portfolio returns.

LO 65.6

There are several points to consider when deciding to allocate portfolio resources to illiquid assets:

1. Studies show that illiquid assets do not deliver higher risk-adjusted returns.

2. Investors are subject to agency problems because one must rely on the talents and skills of portfolio managers. It is difficult to monitor external managers.

3. In many firms, illiquid assets are managed separately from the rest of the portfolio.

4. Illiquid asset investors face high idiosyncratic risks. There is no "market" portfolio of illiquid assets. Illiquid assets are compelling because illiquid asset markets are less efficient than stock and bond markets, there are large information asymmetries in illiquid asset markets, high transaction costs keep many investors out of the market, management skill is crucial, and alpha opportunities are widely dispersed.

Concept Checkers

1. Global liquidity crises generally occur because:
   A. governments choose not to engage in monetary policy actions to stimulate economies.
   B. financial distress causes markets to freeze.
   C. markets for illiquid assets shrink, causing liquidity issues to infect traditional asset classes.
   D. transaction costs increase as developing economies get stronger.

2. When an investor has difficulty finding a counterparty for a complicated credit product like a structured debt instrument, this is known as:
   A. market participation costs.
   B. agency costs.
   C. search frictions.
   D. selection bias.

3. Blue Sky Funds, a private equity fund, has suffered low returns for the last five years. As a result, the find has decided to quit reporting returns. The fund did report returns each year for the last 10 years when performance was strong. This problem of reporting leads to:
   A. survivorship bias.
   B. sample selection bias.
   C. infrequent trading bias.
   D. attrition bias.

4. Which of the following variables is not an illiquidity factor that affects equity returns?
   A. Measures of adverse selection.
   B. The number of recorded positive returns.
   C. Turnover.
   D. Volume.

5. Rick Faircloth, a general partner and portfolio manager with Faircloth Funds, is considering ways in which his company can profit from illiquidity risk premiums. He has studied several alternative methods for harvesting illiquidity risk premiums. Which of the following strategies might Faircloth implement that will likely have the greatest effect on portfolio returns?
   A. Acting as a market maker for individual securities.
   B. Choosing the most illiquid assets within an asset class, even if the asset class is generally considered to be liquid.
   C. Allocating a portion of a portfolio to illiquid asset classes.
   D. Using dynamic factor strategies at the aggregate portfolio level.

Concept Checker Answers

1. **B** In stressed economic periods, such as during the 2007–2009 financial crisis, liquidity can dry up. Major liquidity crises have occurred at least once every ten years across the globe, in conjunction with downturns and financial distress.

2. **C** Difficulties finding a counterparty are called search frictions. For example, it may be difficult to find someone to understand/purchase a complicated structured credit product. It may also be difficult to find buyers with sufficient capital to purchase multimillion dollar office towers in major metropolitan areas. No matter how high the transaction costs, it may take weeks, months, or years to transact in some situations. Asymmetric information can also be a type of search friction as investors search for non-predatory counterparties with which to transact.

3. **A** There are no requirements for certain types of funds, like private equity funds, to report returns. As such, poorly performing funds have a tendency to stop reporting. Additionally, many poorly performing funds ultimately fail. Performance studies generally include only those funds that were successful enough to survive over the entire period of analysis, leaving out the returns of funds that no longer exist. Both of these factors result in reported returns that are too high. This is called survivorship bias.

4. **B** There are several variables related to illiquidity that are shown to impact equity returns. They are bid-ask spreads, volume, turnover, volume measured by whether the trade was initiated by buyers or sellers, the ratio of absolute returns to dollar volume, the price impact of large trades, informed trading measures (i.e., adverse selection), quote size and depth, the frequency of trades, the number of zero returns, and return autocorrelations. It is not the number of recorded positive returns, but the number of recorded zero returns, that are relevant.

5. **D** There are four primary ways that investors can harvest illiquidity premiums:

    1. Allocating a portion of the portfolio to illiquid asset classes like real estate (i.e., passive allocation to illiquid asset classes).

    2. Choosing more illiquid assets within an asset class (i.e., liquidity security selection).

    3. Acting as a market maker for individual securities.

    4. Engaging in dynamic factor strategies at the aggregate portfolio level. This means taking long positions in illiquid assets and short positions in liquid assets to harvest the illiquidity risk premium. Of the four ways investors can harvest illiquidity risk premiums, this is the easiest to implement and can have the greatest effect on portfolio returns.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Portfolio Construction

Topic 66

Exam Focus

This topic addresses techniques for optimal portfolio construction. We will discuss important inputs into the portfolio construction process as well as ways to refine the alpha inputs as an alternative to imposing constraints directly into the portfolio optimization calculations. The role of transaction costs in determining optimal rebalancing is also explained. For the exam, pay attention to the discussions of refining alphas and the implications of transaction costs for both rebalancing and dispersion of returns across separately managed portfolios. Also, be prepared to compare and contrast the various methods of portfolio construction: screening, stratification, linear programming, and quadratic programming.

The Portfolio Construction Process

LO 66.1: Distinguish among the inputs to the portfolio construction process.

The process of constructing an optimal investment portfolio requires several inputs:

- *Current portfolio*: The assets and their weights in the current portfolio. Relative to the other inputs, the current portfolio input can be measured with the most certainty.
- *Alphas*: The expected excess returns of portfolio stocks (relative to their expected returns). This input is subject to forecast error and bias.
- *Covariances*: Estimates of covariances are subject to estimation error.
- *Transaction costs*: Transaction costs are estimated and increase as more frequent portfolio changes are made.
- *Active risk aversion*: Refers to the strength of the preference for lower volatility of the difference between actively managed portfolio returns and benchmark portfolio returns.

LO 66.2: Evaluate the methods and motivation for refining alphas in the implementation process.

A portfolio can be optimized, based on the inputs, using mean-variance analysis. In most cases there are significant constraints imposed on the asset weights, either by client or manager requirements. A client (or regulations) may prohibit short sales. A manager may impose an upper limit on active risk or on maximum deviations from benchmark weights. As more constraints are introduced, simple mean-variance analysis, maximizing active return minus a penalty for active risk, can become quite complex.

An alternative approach is to adjust the manager's estimated alphas (an input into a mean-variance optimization analysis) in ways that effectively impose the various constraints. Consider an account for which short selling is prohibited. Rather than performing an optimization that constrains asset weights to be non-negative, we can use the optimization

equations (in reverse) to solve for the set of alphas that would produce non-negative weights in an unconstrained mean-variance optimization. The optimal weights are moved toward benchmark weights. This method allows us to focus on the effects of a specific constraint on alphas, the key input for active portfolio construction.

Before we examine refining alphas to satisfy other constraints, such as a constraint on the beta of the active portfolio, we consider two techniques that are often employed after refining alphas for various client or manager imposed constraints: **scaling** and **trimming**.

An often used equation for **alpha** is:

$$\text{alpha} = (\text{volatility}) \times (\text{information coefficient}) \times (\text{score})$$

Where *volatility* refers to residual risk, the *information coefficient* (IC) measures the linear relationship between the manager's forecasted asset alphas and actual asset returns, and *score* is expected to be approximately normally distributed with a mean of 0 and a standard deviation of 1. Considering that volatility (residual risk) and information coefficient (IC) are relatively constant, we can see that the standard deviation (scale) of portfolio alphas is proportional to the standard deviation of the score variable. Alphas will have a mean of zero and a scale approximately equal to volatility × information coefficient when score follows a standard normal distribution. With an information coefficient of 0.10 and residual risk of 30%, the scale of the alphas will be 0.10 × 30% = 3%; the alphas will have a mean of zero and a standard deviation of 3%.

If we compare the scale (standard deviation) of the refined alphas from our earlier discussion of a prohibition on short sales to the scale of the original unconstrained alphas, we can calculate the decrease in the information coefficient that results from the decrease in the scale of the alphas due to the imposition of the constraint. If the adjusted alphas do not have the appropriate scale, they can be rescaled.

Another refinement to manager alphas is to reduce large positive or negative alpha values, a process called trimming. The threshold for "large" values might be three times the scale of the alphas. For large alpha values, the reasons supporting these values are re-examined. Any alphas found to be the result of questionable data are set to zero. Additionally, the remaining large alphas may be reduced to some maximum value, typically some multiple of the scale of the alphas.

LO 66.3: Describe neutralization and methods for refining alphas to be neutral.

Neutralization is the process of removing biases and undesirable bets from alpha. There are several types of neutralization: benchmark, cash, and risk-factor. In all cases, the type of neutralization and the strategy for the process should be specified before the process begins.

Benchmark neutralization eliminates any difference between the benchmark beta and the beta of the active portfolio. In this case we say the portfolio alpha of the active portfolio is zero. Consider an active portfolio that has a beta of 1.1 when the benchmark portfolio has a beta of 1. This represents an active bet on market (and benchmark portfolio) returns. When market returns are high, the active portfolio will outperform the benchmark portfolio;

when returns are low (less than the risk-free rate) the active portfolio will underperform the benchmark portfolio. The alphas can be adjusted so that the active portfolio beta is the same as the benchmark portfolio beta, unless the manager intends to make an active bet by increasing or decreasing the active portfolio beta relative to that of the benchmark. Matching the beta of the active portfolio to the beta of the benchmark portfolio is referred to as **benchmark neutralization.** Note that this neutralization is equivalent to adding a constraint on portfolio beta in a mean-variance optimization.

Computing modified benchmark-neutral alpha involves subtracting (benchmark alpha × active position beta) from the alpha of the active position. For example, assume benchmark alpha is equal to 0.013%. If an active position has an alpha of 0.5% and a beta of 1.2, the modified benchmark-neutral alpha will equal: 0.5% – (0.013% × 1.2) = 0.48%.

In the explanation, we used a single risk factor, market risk. There may be other risk factors, such as those from a multi-factor returns generating model, that lead to unintended risk exposures relative to the benchmark. For example, consider the risk factor small cap returns minus large cap returns. The alpha inputs may produce an active portfolio with a greater sensitivity to this risk factor if the portfolio's weight on small-cap firms is larger than that of the benchmark portfolio. Again, if this is unintended, alphas can be adjusted so that the beta of the active portfolio with respect to this risk factor matches that of the benchmark portfolio.

The active portfolio may also be neutralized with respect to industry risk factors, by matching the portfolio weights of each industry to those of the benchmark portfolio. In this case, subtracting the average alpha for an industry from the alphas of each firm within that industry will result in an active portfolio that is neutral relative to the benchmark with respect to industry risk factors. In each of our examples, neutralization reduces active risk by matching the factor risks of the active portfolio to those of the benchmark portfolio.

An active portfolio can also be made **cash neutral**, by adjusting the alphas so that the portfolio has no active cash position. It's possible to make the alpha values both cash- and benchmark-neutral.

Transaction Costs

LO 66.4: Describe the implications of transaction costs on portfolio construction.

Transaction costs are the costs changing portfolio allocations, primarily trading commissions and spreads. Transaction costs reduce active portfolio returns relative to those of the benchmark portfolio and are uncertain, although typically less so than alphas. Because of this, transaction costs are an important input into the portfolio optimization process. Including transaction costs in portfolio optimization increases the importance of both precision in estimating alphas and of the choice of scale.

Transaction costs occur at points in time, while the benefits (i.e., additional return) are realized over time. Consider two stocks, one of which will return 2% over 6 months, at which time it can be replaced by another stock that returns 2% over 6 months, and another stock which will return 4% over 1 year. Also, assume transaction costs are 1%. The annual returns on the first stock will be approximately (2% – 1%) × 2 = 2% and the annual returns

on the second stock will be approximately 4% – 1% = 3%. With uncertain holding periods across portfolio holdings, the question arises over what period transaction costs should be amortized. Precision in scale is important in addressing the tradeoff between alphas and transaction costs. Annual transaction costs will be the cost of a round-trip trade divided by the holding period in years.

Practical Issues

LO 66.5: Assess the impact of practical issues in portfolio construction, such as determination of risk aversion, incorporation of specific risk aversion, and proper alpha coverage.

We need a measure of **active risk aversion** as an input to determine the optimal portfolio. As a practical matter, a portfolio manager does not likely have an intuitive idea of optimal active risk aversion in mind, but will have good intuition about his information ratio (the ratio of alpha to standard deviation) and the amount of active risk (as opposed to active risk aversion) he is willing to accept in pursuit of active returns. An equation that translates those values into a measure of active risk aversion is:

$$\text{risk aversion} = \frac{\text{information ratio}}{2 \times \text{active risk}}$$

For example, if the information ratio is 0.8 and the desired level of active risk is 10%, then the implied level of risk aversion is:

$$\frac{0.80}{2 \times 10} = 0.04$$

The utility function for the optimization is: utility = active return – (0.04 × variance). Of course, the accuracy of the estimate of active risk aversion is dependent on the accuracy of the inputs, the information ratio, and the preferred level of active risk.

Professor's Note: Remember that active risk is just another name for tracking error. Also note that in the risk aversion equation, the desired level of active risk is measured in percentage points rather than in decimal form.

In addition to active risk aversion, **aversion to specific factor risk** is important for two reasons. First, it can help the manager address the risks associated with having a position with the potential for large losses. For example, the risk from a portfolio with sector risks that do not match those of the benchmark portfolio. Second, appropriately high risk aversion values for specific factor risks will reduce dispersion (of holdings and performance) across portfolios when the manager manages more than one portfolio. Setting high risk aversion values for factor specific risks will increase the similarity of client portfolios so that they will tend to hold the same assets. Considering these two effects of specific factor risk aversion values will help a manager determine appropriate values to include in portfolio optimization.

Proper **alpha coverage** refers to addressing situations where the manager has forecasts of stocks that are not in the benchmark or where the manager does not have alpha forecasts for stocks in the benchmark. When the manager has information on stocks not in the benchmark, a benchmark weight of zero should be assigned for benchmarking, but active weights can be assigned to these stocks to generate active alpha.

When there is not an alpha forecast for stocks in the benchmark, adjusted alphas can be inferred from the alphas of stocks for which there are forecasts. One approach is to first compute the following two measures:

$$\text{value-weighted fraction of stocks with forecasts} = \text{sum of active holdings with forecasts}$$

$$\text{average alpha for the stocks with forecasts} = \frac{\text{(weighted average of the alphas with forecasts)}}{\text{(value-weighted fraction of stocks with forecasts)}}$$

The second step is to subtract this measure from each alpha for which there is a forecast and set alpha to zero for assets that do not have forecasts. This provides a set of benchmark-neutral forecasts where assets without forecasts have alphas of zero.

Portfolio Revisions and Rebalancing

LO 66.6: Describe portfolio revisions and rebalancing, and evaluate the tradeoffs between alpha, risk, transaction costs, and time horizon.

LO 66.7: Determine the optimal no-trade region for rebalancing with transaction costs.

If transaction costs are zero, a manager should revise a portfolio every time new information arrives. However, as a practical matter, a manager should make trading decisions based on expected active return, active risk, and transaction costs. The manager may wish to be conservative because these measures are uncertain. Underestimating transaction costs, for example, will lead to trading too frequently. In addition, the frequent trading and short time horizons would cause alpha estimates to exhibit a great deal of uncertainty. Therefore, the manager must choose an optimal time horizon where the certainty of the alpha is sufficient to justify a trade given the transaction costs.

The rebalancing decision depends on the tradeoff between transaction costs and the value added from changing the position. Portfolio managers must be aware of the existence of a *no-trade region* where the benefits of rebalancing are less than the costs. The benefit of adjusting the number of shares of a given portfolio asset is given by the following expression:

$$\begin{aligned}\text{marginal contribution to value added} = {} & \text{(alpha of asset)} - [2 \times \text{(risk aversion)} \times \text{(active risk)} \\ & \times \text{(marginal contribution to active risk of asset)}]\end{aligned}$$

If this value is between the negative cost of selling and the cost of purchase, the manager would not trade that particular asset. In other words, the no-trade region is as follows:

–(cost of selling) < (marginal contribution to value added) < (cost of purchase)

Rearranging this relationship with respect to alpha gives a no-trade region for alpha:

[2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] – (cost of selling) < alpha of asset < [2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] + (cost of purchase)

The size of the no-trade region is determined by transaction costs, risk aversion, alpha, and the riskiness of the assets.

Portfolio Construction Techniques

LO 66.8: Evaluate the strengths and weaknesses of the following portfolio construction techniques: screens, stratification, linear programming, and quadratic programming.

The following four procedures comprise most of the institutional portfolio construction techniques: screens, stratification, linear programming, and quadratic programming. In each case the goal is the same: high alpha, low active risk, and low transaction costs.

An active manager's value depends on her ability to increase returns relative to the benchmark portfolio that are greater than the penalty for active risk and the additional transaction costs of active management.

(portfolio alpha) – (risk aversion) × (active risk)^2 – (transaction costs)

Screens

Screens are just what you would expect; they allow some stocks "through" but not the rest. A screen can be designed in many ways, but two examples will illustrate how a screen might be used with alpha values to select portfolio stocks (given a universe of 200 stocks). Consider a screen that selects the 60 benchmark stocks with the greatest alphas. We could then construct a portfolio of these high-alpha stocks, either equal- or value-weighted.

Another screening method is based on assigning buy, hold, or sell ratings to all the stocks in the manager's universe of investable stocks. For example, we could assign a buy rating to the 60 stocks with the greatest alphas, a hold rating to the 40 remaining stocks with the next highest alphas, and a sell rating to the remaining stocks under consideration. One way to rebalance the current portfolio would be to purchase any stocks on the buy list not currently in the portfolio and to sell any portfolio stocks on the sell list. Portfolio turnover can be adjusted by adjusting the sizes of the categories.

Stratification

Stratification refers to dividing stocks into multiple mutually exclusive categories prior to screening the stocks for inclusion in the portfolio. For example, we could divide the portfolio into large-cap, medium-cap, and small-cap stocks and further divide these categories into six different industry categories; giving us 18 different size-sector categories. By using percentage weights of these size-sector categories in the benchmark portfolio we can match the benchmark portfolio's size and sector coverage.

Stratification is a method of risk control. If the size and sector categories are chosen in such a way that they capture the risk dimensions of the benchmark well, portfolio risk control will be significant. If they are not, risk control will not be achieved.

Stratification will reduce the effects of bias in estimated alphas across the categories of firm size and sector. However, it takes away the possibility of adding value by deviating from benchmark size-sector weights. Using stratification, any value from information about actual alphas (beyond their category) and about possible sector alphas is lost.

Linear Programming

Linear programming is an improvement on stratification, in that it uses several risk characteristics, for example, firm size, returns volatility, sector, and beta. Unlike stratification, it does not require mutually exclusive categories of portfolio stocks. The linear programming methodology will choose assets for the optimal portfolio so that category weights in the active portfolio closely resemble those of the benchmark portfolio. This technique can also include the effects of transaction costs (which reduces turnover) and limits on position sizes.

Linear programming's strength is creating a portfolio that closely resembles the benchmark. However, the result can be a portfolio that is very different from the benchmark with respect to the number of assets included and any unincluded dimensions of risk.

Quadratic Programming

Quadratic programming can be designed to include alphas, risks, and transaction costs. Additionally, any number of constraints can be imposed. Theoretically, this is the best method of optimization, as it efficiently uses the information in alphas to produce the optimal (constrained) portfolio. However, estimation error is an important consideration. Consider that for a universe of 400 stocks, quadratic programming will require estimates of 400 stock volatilities and 79,800 covariances. The quadratic program will use the information in the estimates to reduce active risk.

Small estimation error in covariances will not necessarily reduce value added significantly. But even moderate levels of estimation error for the covariances can significantly reduce value added; with 5% estimation error, value added may actually be negative. The importance of good estimates of the relevant inputs, especially covariances, cannot be over emphasized.

Portfolio Return Dispersion

LO 66.9: Describe dispersion, explain its causes, and describe methods for controlling forms of dispersion.

For portfolio managers, **dispersion** refers to the variability of returns across client portfolios. One dispersion measure is the difference between the maximum return and minimum return over a period for separately managed client accounts.

Managers can reduce dispersion by reducing differences in asset holdings between portfolios and differences in portfolio betas though better supervision and control. Other causes of dispersion are outside the manager's control. Different portfolio constraints for different accounts will unavoidably increase dispersion (e.g., not being able to invest in derivatives or other asset classes).

Of course, if all client accounts were identical there would be no dispersion. All accounts will not be identical in the presence of transaction costs, however. The existence of transaction costs implies that there is some optimal level of dispersion. To understand the tradeoff between transaction costs and dispersion, consider a managed portfolio that is currently 60% stocks and 40% bonds. The manager knows the optimal portfolio is 62% stocks and 38% bonds, but transaction costs from rebalancing would reduce returns more than the change to optimal weights would increase them.

If the manager acquires a second client, he can set portfolio weights to 62% and 38% for that client's account. Because one client has a 60/40 portfolio and the other has a 62/38 portfolio, there will be dispersion. Clearly, higher transaction costs lead to greater dispersion. If the manager eliminates dispersion by matching the new client portfolio to the existing client portfolio, returns from the new information will be sacrificed. If the manager eliminates dispersion by rebalancing the existing client portfolio, the transaction costs of this rebalancing will reduce overall portfolio return. Given transaction costs, there is an optimal level of dispersion that balances transaction costs and gains from rebalancing.

A greater number of portfolios and higher active risk will both increase optimal dispersion, and for a given number of portfolios, dispersion is proportional to active risk. As long as alphas and risk are not constant (an unlikely occurrence) dispersion will decrease over time and eventually convergence (of account returns) will occur. However, there is no certainty as to the rate at which it will occur.

Key Concepts

LO 66.1

The inputs into the portfolio construction process are the current portfolio, the alphas, covariance estimates, transaction costs, and active risk aversion. Except for the current portfolio, these inputs are all subject to estimation error and possible bias.

LO 66.2

Refining alphas is an alternative to including constraints (e.g., no short selling or maximum deviations from benchmark weights) in the portfolio optimization process. Using refined alphas and then performing optimization can achieve the same goal as a constrained optimization approach, but has the advantage of focusing on the alpha inputs and the effects of individual constraints on portfolio returns.

LO 66.3

Neutralization can remove undesirable portfolio risks. Benchmark neutralization can reduce active risk by matching active portfolio beta to that of the benchmark portfolio. Cash neutralization eliminates any active cash position in the portfolio. Risk-factor neutralization matches specific factor risks in the active portfolio to those of the benchmark.

LO 66.4

Transaction costs have several implications. First, they may make it optimal not to rebalance even with the arrival of new information. Second, transaction costs increase the importance of robust alpha estimates. The fact that transaction costs occur at a point in time while the benefits of the portfolio adjustments occur over the investment horizon complicates analysis and makes rebalancing decisions dependent on the estimated holding period of portfolio assets.

LO 66.5

Practical issues in portfolio construction include determining the level of risk aversion, the optimal risk, and the alpha coverage. The inputs in computing the level of risk aversion must be accurate. Including the aversion to specific risk factors can help a manager address the risks of a position with a large potential loss and the dispersion across separately managed portfolios. Proper alpha coverage addresses situations in which the manager has alpha estimates for stocks that have zero weight in (are not included in) the benchmark or does not have alpha estimates for some stocks in the benchmark portfolio.

LO 66.6

In the process of portfolio revisions and rebalancing, there are tradeoffs between alpha, risk, transaction costs, and the investment horizon. The manager may choose to be conservative, given the uncertainty regarding these inputs. Also, the shorter the horizon, the more uncertain the alpha, which means the manager should choose an optimal time horizon where the certainty of the alpha is sufficient to justify a trade given the transaction costs.

LO 66.7

Because of transaction costs, there will be an optimal no-trade region when new information arrives concerning the alpha of an asset, the costs of rebalancing the portfolio outweigh the expected incremental returns. That region is determined by the level of risk aversion, a portfolio's active risk, the marginal contribution of rebalancing to active risk, and transaction costs.

LO 66.8

A screen may be as simple as "screening" for assets with the highest estimated alphas or as a method of assigning relative ranks based on estimated alphas.

Stratification applies screening separately to categories of stocks and weights the active portfolio across these categories with their weights in the benchmark portfolio.

Linear programming is an improvement on stratification in that the optimal portfolio is structured to closely resemble the benchmark with respect to such characteristics (risk factors) as industry groups, firm size, volatility, and beta.

Quadratic programming improves on the linear programming methodology by explicitly considering alpha, risk, and transaction costs. It is theoretically the best optimization method, incorporating the most information; however, the value added in the active portfolio is quite sensitive to the level of estimation error in the covariance inputs.

LO 66.9

For a manager with separately managed accounts, dispersion of client returns will result when the portfolios are not identical. The basic causes of dispersion are the different histories and cash flows of each of the clients. A manager can control this source of dispersion by trying to increase the proportion of assets that are common to all portfolios.

Concept Checkers

1. The most measurable of the inputs into the portfolio construction process is(are):
   A. the position alphas.
   B. the transaction costs.
   C. the current portfolio.
   D. the active risk aversion.

2. Which of the following is correct with respect to adjusting the optimal portfolio for portfolio constraints?
   A. No reliable method exists.
   B. By refining the alphas and then optimizing, it is possible to include constraints of both the investor and the manager.
   C. By refining the alphas and then optimizing, it is possible to include constraints of the investor, but not the manager.
   D. By optimizing and then refining the alphas, it is possible to include constraints of both the investor and the manager.

3. An increase in which of the following factors will increase the no-trade region for the alpha of an asset?

   I. Risk aversion.
   II. Marginal contribution to active risk.

   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

4. Which of the following statements most correctly describes a consideration that complicates the incorporation of transaction costs into the portfolio construction process?
   A. The transaction costs and the benefits always occur in two distinct time periods.
   B. The transaction costs are uncertain while the benefits are relatively certain.
   C. There are no complicating factors from the introduction of transaction costs.
   D. The transaction costs must be amortized over the horizon of the benefit from the trade.

5. A manager has forecasts of stocks A, B, and C, but not of stocks D and E. Stocks A, B, and D are in the benchmark portfolio. Stocks C and E are not in the benchmark portfolio. Which of the following is correct concerning specific weights the manager should assign in tracking the benchmark portfolio?
   A. $w_C = 0$.
   B. $w_D = 0$.
   C. $w_C = (w_A + w_B)/2$.
   D. $w_C = w_D = w_E$.

Concept Checker Answers

1. **C** The current portfolio is the only input that is directly observable.

2. **B** The approach of first refining alphas and then optimizing can replace even the most sophisticated portfolio construction process. With this technique, both the investor and manager constraints are considered.

3. **C** This is evident from the definition of the no-trade region for the alpha of the asset.

   [2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] – (cost of selling) < alpha of asset < [2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] + (cost of purchase)

4. **D** A challenge is to correctly assign the transaction costs to projected future benefits. The transaction costs must be amortized over the horizon of the benefit from the trade. The benefits (e.g., the increase in alpha) occur over time while the transaction costs generally occur at a specific time when the portfolio is adjusted.

5. **A** The manager should assign a tracking portfolio weight equal to zero for stocks for which there is a forecast but that are not in the benchmark. A weight should be assigned to stock D, and it should be a function of the alphas of the other assets.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Portfolio Risk: Analytical Methods

Topic 67

Exam Focus

Due to diversification, the value at risk (VaR) of a portfolio will be less than or equal to the sum of the VaRs of the positions in the portfolio. If all positions are perfectly correlated, then the portfolio VaR equals the sum of the individual VaRs. A manager can make optimal adjustments to the risk of a portfolio with such measures as marginal VaR, incremental VaR, and component VaR. This topic is highly quantitative. Be able to find the optimal portfolio using the excess-return-to-marginal VaR ratios. For the exam, understand how correlations impact the measure of portfolio VaR. Also, it is important that you know how to compute incremental VaR and component VaR using the marginal VaR measure. We have included several examples to help with application of these concepts.

Portfolio theory depends a lot on statistical assumptions. In finance, researchers and analysts often assume returns are normally distributed. Such an assumption allows us to express relationships in concise expressions such as beta. Actually, beta and other convenient concepts can apply if returns follow an elliptical distribution, which is a broader class of distributions that includes the normal distribution. In what follows, we will assume returns follow an elliptical distribution unless otherwise stated.

LO 67.1: Define, calculate, and distinguish between the following portfolio VaR measures: individual VaR, incremental VaR, marginal VaR, component VaR, undiversified portfolio VaR, and diversified portfolio VaR.

Professor's Note: LO 67.1 is addressed throughout this topic.

Diversified Portfolio VaR

Diversified VaR is simply the VaR of the portfolio where the calculation takes into account the diversification effects. The basic formula is:

$$VaR_p = Z_c \times \sigma_p \times P$$

where:
Z_c = the *z*-score associated with the level of confidence *c*
σ_p = the standard deviation of the portfolio return
P = the nominal value invested in the portfolio

Examining the formula for the variance of the portfolio returns is important because it reveals how the correlations of the returns of the assets in the portfolio affect volatility. The variance formula is:

$$\sigma_P^2 = \sum_{i=1}^{N} w_i^2 \sigma_i^2 + 2 \sum_{i=1}^{N} \sum_{j<i}^{N} w_i w_j \rho_{i,j} \sigma_i \sigma_j$$

where:
σ_P^2 = the variance of the portfolio returns
w_i = the portfolio weight invested in position *i*
σ_i = the standard deviation of the return in position *i*
$\rho_{i,j}$ = the correlation between the returns of asset *i* and asset *j*

The standard deviation, denoted σ_P, is:

$$\sigma_P = \sqrt{\sigma_P^2} = \sqrt{\sum_{i=1}^{N} w_i^2 \sigma_i^2 + 2 \sum_{i=1}^{N} \sum_{j<i}^{N} w_i w_j \rho_{i,j} \sigma_i \sigma_j}$$

Clearly, the variance and standard deviation are lower when the correlations are lower.

In order to calculate delta-normal VaR with more than one risk factor, we need a covariance matrix that incorporates correlations between each risk factor in the portfolio and volatilities of each risk factor. If we know the volatilities and correlations, we can derive the standard deviation of the portfolio and the corresponding VaR measure. We will discuss how to calculate VaR using matrix multiplication later in this topic.

Individual VaR is the VaR of an individual position in isolation. If the proportion or weight in the position is w_i, then we can define the individual VaR as:

$$VaR_i = Z_c \times \sigma_i \times |P_i| = Z_c \times \sigma_i \times |w_i| \times P$$

where:
P = the portfolio value
P_i = the nominal amount invested in position i

We use the absolute value of the weight because both long and short positions pose risk.

LO 67.2: Explain the role of correlation on portfolio risk.

In a two-asset portfolio, the equation for the standard deviation is:

$$\sigma_P = \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2\, w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2}$$

and the VaR is:

$$VaR_P = Z_c P \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2\, w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2}$$

We can square Z_c and P and put them under the square-root sign. This allows us to express VaR_P as a function of the VaRs of the individual positions, which we express as VaR_i for each position i. For a two-asset portfolio we will have VaR_1 and VaR_2. If the correlation is zero, $\rho_{1,2} = 0$, then the third term under the radical is zero and:

$$\text{VaR for uncorrelated positions: } VaR_P = \sqrt{VaR_1^2 + VaR_2^2}$$

The other extreme is when the correlation is equal to unity, $\rho_{1,2} = \pm 1$. With perfect correlation, there is no benefit from diversification. For the two-asset portfolio, we find:

$$\text{Undiversified VaR} = VaR_P = \sqrt{VaR_1^2 + VaR_2^2 + 2VaR_1VaR_2} = VaR_1 + VaR_2$$

In general, undiversified VaR is the sum of all the VaRs of the individual positions in the portfolio when none of those positions are short positions.

Notice how evaluating VaR using both uncorrelated positions and perfectly correlated positions will place a lower and upper bound on the total (or portfolio) VaR. Total VaR will be less if the positions are uncorrelated and greater if the positions are correlated. The greatest risk is a correlation of –1 where one asset magnifies the loss of the other asset. The following examples illustrate this point.

Example: Computing portfolio VaR (part 1)

An analyst computes the VaR for the two positions in her portfolio. The VaRs: VaR_1 = \$2.4 million and VaR_2 = \$1.6 million. **Compute** VaR_P if the returns of the two assets are uncorrelated.

Answer:

For uncorrelated assets:

$$VaR_P = \sqrt{VaR_1^2 + VaR_2^2} = \sqrt{\left(2.4^2 + 1.6^2\right)(\$\text{millions})^2} = \sqrt{8.32(\$\text{millions})^2}$$

$$VaR_P = \$2.8844 \text{ million}$$

Example: Computing portfolio VaR (part 2)

An analyst computes the VaR for the two positions in her portfolio. The VaRs: VaR_1 = \$2.4 million and VaR_2 = \$1.6 million. **Compute** VaR_P if the returns of the two assets are perfectly correlated.

Answer:

For perfectly correlated assets:

$$VaR_P = VaR_1 + VaR_2 = \$2.4 \text{ million} + \$1.6 \text{ million} = \$4 \text{ million}$$

Under certain assumptions, the portfolio standard deviation of returns for a portfolio with more than two assets has a very concise formula. The assumptions are:

- The portfolio is equally weighted.
- All the individual positions have the same standard deviation of returns.
- The correlations between each pair of returns are the same.

The formula is then:

$$\sigma_P = \sigma\sqrt{\frac{1}{N} + \left(1 - \frac{1}{N}\right)\rho}$$

where:
N = the number of positions
σ = the standard deviation that is equal for all *N* positions
ρ = the correlation between the returns of each pair of positions

Professor's Note: This formula greatly simplifies the process of having to calculate portfolio standard deviation with a covariance matrix.

To demonstrate the benefits of diversification, we can simply set up a 2 × 2 table where there is a small and large correlation (ρ) column and a small and large sample size (*N*) row. Assuming that the standard deviation of returns is 20% for both assets, we see how the portfolio variance is affected by the different inputs.

Figure 1: Portfolio Standard Deviation

Sample size/correlation	ρ = *0.1*	ρ = *0.5*
N = 4	σ_P = 11.40%	σ_P = 15.81%
N = 10	σ_P = 8.72%	σ_P = 14.83%

Example: Computing portfolio VaR (part 3)

A portfolio has five positions of $2 million each. The standard deviation of the returns is 30% for each position. The correlations between each pair of returns is 0.2. **Calculate** the VaR using a Z-value of 2.33.

Answer:

The standard deviation of the portfolio returns is:

$$\sigma_P = 30\%\sqrt{\frac{1}{5} + \left(1-\frac{1}{5}\right)0.2}$$

$$\sigma_P = 30\%\sqrt{0.36}$$

$$\sigma_P = 18\%$$

The VaR in nominal terms is:

$$VaR_p = Z_c \times \sigma_p \times V = (2.33)(18\%)(\$10 \text{ million})$$

$$VaR_p = \$4{,}194{,}000$$

Marginal VaR

Marginal VaR applies to a particular position in a portfolio, and it is the *per unit change in a portfolio VaR that occurs from an additional investment in that position.* Mathematically speaking, it is the partial derivative of the portfolio VaR with respect to the position:

$$\text{Marginal VaR} = MVaR_i = \frac{\partial VaR_P}{\partial(\text{monetary investment in i})} = Z_c \frac{\partial \sigma_P}{\partial w_i} = Z_c \frac{\text{cov}(R_i, R_P)}{\sigma_P}$$

Using CAPM methodology, we know a regression of the returns of a single asset *i* in a portfolio on the returns of the entire portfolio gives a beta, denoted β_i, which is a concise measure that includes the covariance of the position's returns with the total portfolio:

$$\beta_i = \frac{\text{cov}(R_i, R_P)}{\sigma_P^2}$$

Using the concept of beta gives another expression for marginal VaR:

$$\text{Marginal VaR} = MVaR_i = \frac{VaR_P}{\text{portfolio value}} \times \beta_i$$

Example: Computing marginal VaR

Assume Portfolio X has a VaR of €400,000. The portfolio is made up of four assets: Asset A, Asset B, Asset C, and Asset D. These assets are equally weighted within the portfolio and are each valued at €1,000,000. Asset A has a beta of 1.2. **Calculate** the marginal VaR of Asset A.

Answer

$$\text{Marginal VaR}_A = (\text{VaR}_P / \text{portfolio value}) \times \beta_A$$

$$\text{Marginal VaR}_A = (400{,}000 / 4{,}000{,}000) \times 1.2 = 0.12$$

Thus, portfolio VaR will change by 0.12 for each euro change in Asset A.

Incremental VaR

LO 67.3: Describe the challenges associated with VaR measurement as portfolio size increases.

Incremental VaR is the change in VaR from the addition of a new position in a portfolio. Since it applies to an entire position, it is generally larger than marginal VaR and may include nonlinear relationships, which marginal VaR generally assumes away. The problem with measuring incremental VaR is that, in order to be accurate, a full revaluation of the portfolio after the addition of the new position would be necessary. The incremental VaR is the difference between the new VaR from the revaluation minus the VaR before the addition. The revaluation requires not only measuring the risk of the position itself, but it also requires measuring the change in the risk of the other positions that are already in the portfolio. For a portfolio with hundreds or thousands of positions, this would be time consuming. Clearly, VaR measurement becomes more difficult as portfolio size increases given the expansion of the covariance matrix. Using a shortcut approach for computing incremental VaR would be beneficial.

For small additions to a portfolio, we can approximate the incremental VaR with the following steps:

Step 1: Estimate the risk factors of the new position and include them in a vector [η].
Step 2: For the portfolio, estimate the vector of marginal VaRs for the risk factors [MVaR_j].
Step 3: Take the cross product.

This probably requires less work and is faster to implement because it is likely the managers already have estimates of the vector of MVaR_j values in Step 2.

Before we take a look at how to calculate incremental VaR, let's review the calculation of delta-normal VaR using matrix notation (i.e., using a covariance matrix).

Example: Computing VaR using matrix notation

A portfolio consists of assets A and B. These assets are the risk factors in the portfolio. The volatilities are 6% and 14%, respectively. There are $4 million and $2 million invested in them, respectively. If we assume they are uncorrelated with each other, **compute** the VaR of the portfolio using a confidence parameter, Z, of 1.65.

Answer:

We can use matrix notation to derive the dollar variance of the portfolio:

$$\sigma_P^2 V^2 = [\$4\ \$2]\begin{bmatrix}0.06^2 & 0\\ 0 & 0.14^2\end{bmatrix}\begin{bmatrix}\$4\\ \$2\end{bmatrix} = 0.0576 + 0.0784 = 0.136$$

This value is in ($ millions)^2. VaR is then the square root of the portfolio variance times 1.65:

$$\text{VaR} = (1.65)(\$368{,}782) = \$608{,}490$$

Professor's Note: Matrix multiplication consists of multiplying each row by each column. For example: $(4 \times 0.06^2) + (2 \times 0) = 0.0144$; $0.0144 \times 4 = 0.0576$. Had the positions been positively correlated, some positive value would replace the zeros in the covariance matrix.

Example: Computing incremental VaR

A portfolio consists of assets A and B. The volatilities are 6% and 14%, respectively. There are $4 million and $2 million invested in them respectively. If we assume they are uncorrelated with each other, **compute** the incremental VaR for an increase of $10,000 in Asset A. Assume a Z-score of 1.65.

Answer:

To find incremental VaR, we compute the per dollar covariances of each risk factor:

$$\begin{bmatrix}\text{cov}(R_A, R_P)\\ \text{cov}(R_B, R_P)\end{bmatrix} = \begin{bmatrix}0.06^2 & 0\\ 0 & 0.14^2\end{bmatrix}\begin{bmatrix}\$4\\ \$2\end{bmatrix} = \begin{bmatrix}0.0144\\ 0.0392\end{bmatrix}$$

These per dollar covariances represent the covariance of a given risk factor with the portfolio. Thus, we can substitute these values into the marginal VaR equations for the risk factors as follows.

The marginal VaRs of the two risk factors are:

$$MVaR_A = Z_c \times \frac{cov(R_A, R_P)}{\sigma_P} = 1.65 \times \frac{0.0144}{\sqrt{0.136}} = 0.064428$$

$$MVaR_B = Z_c \times \frac{cov(R_B, R_P)}{\sigma_P} = 1.65 \times \frac{0.0392}{\sqrt{0.136}} = 0.175388$$

Since the two assets are uncorrelated, the incremental VaR of an additional $10,000 investment in Position A would simply be $10,000 times 0.064428, or $644.28.

Component VaR

Component VaR for position *i*, denoted $CVaR_i$, is the amount of risk a particular fund contributes to a portfolio of funds. It will generally be less than the VaR of the fund by itself (i.e., stand alone VaR) because of diversification benefits at the portfolio level. In a large portfolio with many positions, the approximation is simply the marginal VaR multiplied by the dollar weight in position *i*:

$$CVaR_i = (MVaR_i) \times (w_i \times P) = VaR \times \beta_i \times w_i$$

$$= (\alpha \times \sigma_p \times P) \times \beta_i \times w_i = (\alpha \times \sigma_i \times w_i \times P) \times \rho_i = VaR_i \times \rho_i$$

The last two components consider the fact that $beta_i = (\rho_i \times \sigma_i) / \sigma_P$.

Using $CVaR_i$, we can express the total VaR of the portfolio as:

$$VaR = \sum_{i=1}^{N} CVaR_i = VaR\left(\sum_{i=1}^{N} w_i \times \beta_i\right)$$

Given the way the betas were computed we know: $\left(\sum_{i=1}^{N} w_i \times \beta_i\right) = 1$

Example: Computing component VaR (Example 1)

Assume Portfolio X has a VaR of €400,000. The portfolio is made up of four assets: Asset A, Asset B, Asset C, and Asset D. These assets are equally weighted within the portfolio and are each valued at €1,000,000. Asset A has a beta of 1.2. **Calculate** the component VaR of Asset A.

Answer:

Component VaR_A = $VaR_P \times \beta_A \times$ asset weight

Component VaR_A = 400,000 × 1.2 × (1,000,000 / 4,000,000) = €120,000

Thus, portfolio VaR will decrease by €120,000 if Asset A is removed.

Example: Computing component VaR (Example 2, Part 1)

Recall our previous incremental VaR example of a portfolio invested $4 million in A and $2 million in B. Using their respective marginal VaRs, 0.064428 and 0.175388, **compute** the component VaRs.

Answer:

$$CVaR_A = (MVaR_A) \times (w_A \times P) = (0.064428) \times (\$4 \text{ million}) = \$257{,}713$$

$$CVaR_B = (MVaR_B) \times (w_B \times P) = (0.175388) \times (\$2 \text{ million}) = \$350{,}777$$

Professor's Note: The values have been adjusted for rounding.

Example: Computing component VaR (Example 2, Part 2)

Using the results from the previous example, **compute** the percent of contribution to VaR of each component.

Answer:

The answer is the sum of the component VaRs divided into each individual component VaR:

$$\%\text{ contribution to VaR from A} = \frac{\$257{,}713}{(\$257{,}713 + \$350{,}777)} = 42.35\%$$

$$\%\text{ contribution to VaR from B} = \frac{\$350{,}777}{(\$257{,}713 + \$350{,}777)} = 57.65\%$$

Normal distributions are a subset of the class of distributions called elliptical distributions. As a class, elliptical distributions have fewer assumptions than normal distributions. Risk management often assumes elliptical distributions, and the procedures to estimate component VaRs up to this point have applied to elliptical distributions.

If the returns do not follow an elliptical distribution, we can employ other procedures to compute component VaR. If the distribution is homogeneous of degree one, for example, then we can use Euler's theorem to estimate the component VaRs. The return of a portfolio of assets is homogeneous of degree one because, for some constant, *k*, we can write:

$$k \times R_P = \sum_{i=1}^{N} k \times w_i \times R_i$$

The following steps can help us find component VaRs for a non-elliptical distribution using historical returns:

Step 1: Sort the historical returns of the portfolio.
Step 2: Find the return of the portfolio, which we will designate $R_{P(VaR)}$, that corresponds to a return that would be associated with the chosen VaR.
Step 3: Find the returns of the individual positions that occurred when $R_{P(VaR)}$ occurred.
Step 4: Use each of the position returns associated with $R_{P(VaR)}$ for component VaR for that position.

To improve the estimates of the component VaRs, an analyst should probably obtain returns for each individual position for returns of the portfolio slightly above and below $R_{P(VaR)}$. For each set of returns for each position, the analyst would compute an average to better approximate the component VaR of the position.

Managing Portfolios Using VaR

LO 67.4: Apply the concept of marginal VaR to guide decisions about portfolio VaR.

LO 67.5: Explain the risk-minimizing position and the risk and return-optimizing position of a portfolio.

A manager can *lower a portfolio VaR by lowering allocations to the positions with the highest marginal VaR*. If the manager keeps the total invested capital constant, this would mean increasing allocations to positions with lower marginal VaR. Portfolio risk will be at a global minimum where all the marginal VaRs are equal for all i and j:

$$MVaR_i = MVaR_j$$

We can use our earlier example to see how we can use marginal VaRs to make decisions to lower the risk of the entire portfolio. In the earlier example, Position A has the smaller MVaR; therefore, we will compute the marginal VaRs and total VaR for a portfolio which has \$5 million invested in A and \$1 million in B. The portfolio variance is:

$$\sigma_p^2V^2 = [\$5\ \$1]\begin{bmatrix}0.06^2 & 0\\ 0 & 0.14^2\end{bmatrix}\begin{bmatrix}\$5\\ \$1\end{bmatrix} = 0.0900 + 0.0196 = 0.1096$$

This value is in (\$ millions)^2. VaR is then the square root of the portfolio variance times 1.65 (95% confidence level):

$$VaR = (1.65)(\$331{,}059) = \$546{,}247$$

The VaR of \$546,247 is less than the VaR of \$608,490, which was produced when Portfolio A had a lower weight. We can see that the marginal VaRs are now much closer in value:

$$\begin{bmatrix}cov(R_A,R_P)\\ cov(R_B,R_P)\end{bmatrix} = \begin{bmatrix}0.06^2 & 0\\ 0 & 0.14^2\end{bmatrix}\begin{bmatrix}\$5\\ \$1\end{bmatrix} = \begin{bmatrix}0.0180\\ 0.0196\end{bmatrix}$$

The marginal VaRs of the two positions are:

$$\text{MVaR}_A = Z_c \times \frac{\text{cov}(R_A, R_P)}{\sigma_P} = 1.65 \times \frac{0.0180}{\sqrt{0.1096}} = 0.08971$$

$$\text{MVaR}_B = Z_c \times \frac{\text{cov}(R_B, R_P)}{\sigma_P} = 1.65 \times \frac{0.0196}{\sqrt{0.1096}} = 0.09769$$

LO 67.6: Explain the difference between risk management and portfolio management, and describe how to use marginal VaR in portfolio management.

As the name implies, risk management focuses on risk and ways to reduce risk; however, minimizing risk may not produce the optimal portfolio. Portfolio management requires assessing both risk measures and return measures to choose the optimal portfolio. Traditional efficient frontier analysis tells us that the minimum variance portfolio is not optimal. We should note that the **efficient frontier** is the plot of portfolios that have the lowest standard deviation for each expected return (or highest return for each standard deviation) when plotted on a plane with the vertical axis measuring return and the horizontal axis measuring the standard deviation. The optimal portfolio is represented by the point where a ray from the risk-free rate is just tangent to the efficient frontier. That optimal portfolio has the highest Sharpe ratio:

$$\text{Sharpe ratio} = \frac{(\text{portfolio return} - \text{risk-free rate})}{(\text{standard deviation of portfolio return})}$$

We can modify this formula by replacing the standard deviation with VaR so that the focus then becomes the excess return of the portfolio over VaR:

$$\frac{(\text{portfolio return} - \text{risk-free rate})}{(\text{VaR of portfolio})}$$

This ratio is maximized when the excess return in each position divided by its respective marginal VaR equals a constant. In other words, at the optimum:

$$\frac{(\text{Position i return} - \text{risk-free rate})}{(\text{MVaR}_i)} = \frac{(\text{Position j return} - \text{risk-free rate})}{(\text{MVaR}_j)}$$

for all positions *i* and *j*

Professor's Note: Equating the excess return/MVaR ratios will obtain the optimal portfolio. This differs from equating just the MVaRs, which obtains the portfolio with the lowest portfolio VaR.

Assuming that the returns follow elliptical distributions, we can represent the condition in a more concise fashion by employing betas, β_i, which are obtained from regressing each position's return on the portfolio return:

$$\frac{(\text{Position i return} - \text{risk-free rate})}{\beta_i} = \frac{(\text{Position j return} - \text{risk-free rate})}{\beta_j}$$

for all positions *i* and *j*

The portfolio weights that make these ratios equal will be the optimal portfolio. We now turn our attention to determining the optimal portfolio for our example portfolio of A and B. We will assume the expected excess return of A is 6% and that of B is 11%. Even without this information, we should know that the optimal portfolio will have an allocation in A less than $5 million and in B greater than $1 million. This is because the marginal VaRs were almost equal with those allocations. *Thus, the resulting portfolio would be close to the minimum variance,* which will not be optimal. We might want to find out how to adjust the allocation with respect to the original values of $4 million in A and $2 million in B. By comparing the ratios of the two assets we find:

$$\frac{\text{Excess return of A}}{\text{MVaR}_A} = \frac{0.06}{0.064428} = 0.9313$$

$$\frac{\text{Excess return of B}}{\text{MVaR}_B} = \frac{0.11}{0.175388} = 0.6272$$

We see that there is too much allocated in B. Before we adjust the portfolio, we compute the excess-return-to-VaR ratio for the entire portfolio. The return is:

$$\%\text{ excess return on portfolio} = 7.67\% = \frac{\$4\text{ million}}{\$6\text{ million}}(6\%) + \frac{\$2\text{ million}}{\$6\text{ million}}(11\%)$$

The return to VaR (scaled by the size of the portfolio) is:

$$0.7559 = \frac{0.0767}{\$608{,}490} \times \$6\text{ million}$$

Now, because the return to MVaR ratio was greater for A, we will increase the allocation in A to $4.5 million and decrease that in B to $1.5 million. With those changes, the portfolio variance is:

$$\sigma_p{}^2V^2 = [\$4.5\ \$1.5]\begin{bmatrix}0.06^2 & 0\\ 0 & 0.14^2\end{bmatrix}\begin{bmatrix}\$4.5\\ \$1.5\end{bmatrix} = 0.0729 + 0.0441 = 0.1170$$

This value is in ($ millions)^2. VaR is then the square root of the portfolio variance times 1.65 (95% confidence level):

VaR = (1.65)($342,053) = $564,387

In this case, the marginal VaRs are found by:

$$\begin{bmatrix}\text{cov}(R_A,R_P)\\ \text{cov}(R_B,R_P)\end{bmatrix}=\begin{bmatrix}0.06^2 & 0\\ 0 & 0.14^2\end{bmatrix}\begin{bmatrix}\$4.5\\ \$1.5\end{bmatrix}=\begin{bmatrix}0.0162\\ 0.0294\end{bmatrix}$$

The marginal VaRs of the two positions are then:

$$\text{MVaR}_A = Z_c \times \frac{\text{cov}(R_A,R_P)}{\sigma_P} = 1.65 \times \frac{0.0162}{\sqrt{0.1170}} = 0.0781$$

$$\text{MVaR}_B = Z_c \times \frac{\text{cov}(R_B,R_P)}{\sigma_P} = 1.65 \times \frac{0.0294}{\sqrt{0.1170}} = 0.1418$$

We see the expected excess-return-to-marginal VaR ratios are much closer:

$$\frac{0.06}{0.0781} = 0.7678$$

$$\frac{0.11}{0.1418} = 0.7756$$

The portfolio return is now:

$$\%\text{ excess return on portfolio} = 7.25\% = \frac{\$4.5\text{ million}}{\$6\text{ million}}(6\%) + \frac{\$1.5\text{ million}}{\$6\text{ million}}(11\%)$$

The portfolio return divided by the portfolio VaR has risen. The return to VaR (scaled by the size of the portfolio) is:

$$0.7707 = \frac{0.0725}{\$564{,}387} \times \$6\text{ million}$$

This is greater than the 0.7559 value associated with the original $4 million and $2 million allocations. The result is a more optimal portfolio allocation.

Key Concepts

LO 67.1

Diversified VaR is simply the VaR of the portfolio where the calculation takes into account the diversification effects.

Individual VaR is the VaR of an individual position in isolation.

Diversified VaR is simply the VaR of the portfolio where the calculation takes into account the diversification effects. The basic formula is:

$$VaR_p = Z_c \times \sigma_p \times P$$

where:
Z_c = the *z*-score associated with the level of confidence *c*
σ_p = the standard deviation of the portfolio return
P = the nominal value invested in the portfolio

Individual VaR is the VaR of an individual position in isolation. If the proportion or weight in the position is w_i, then we can define the individual VaR as:

$$VaR_i = Z_c \times \sigma_i \times |P_i| = Z_c \times \sigma_i \times |w_i| \times P$$

where:
P = the portfolio value
P_i = the nominal amount invested in position i

Marginal VaR is the change in a portfolio VaR that occurs from an additional one unit investment in a given position. Useful representations are:

$$\text{Marginal VaR} = \text{MVaR}_i = Z_c \frac{\text{cov}(R_i, R_P)}{\sigma_P}$$

$$\text{Marginal VaR} = \text{MVaR}_i = \frac{\text{VaR}}{P} \times \beta_i$$

Incremental VaR is the change in VaR from the addition of a new position in a portfolio. It can be calculated precisely from a total revaluation of the portfolio, but this can be costly. A less costly approximation is found by (1) breaking down the new position into risk factors, (2) multiplying each new risk factor times the corresponding partial derivative of the portfolio with respect to the risk factor, and then (3) adding up all the values.

Component VaR for position *i*, denoted $CVaR_i$, is the amount a portfolio VaR would change from deleting that position in a portfolio. In a large portfolio with many positions, the approximation is simply the marginal VaR multiplied by the dollar weight in position *i*:

$$CVaR_i = (MVaR_i) \times (w_i \times P) = VaR \times \beta_i \times w_i$$

There is a method for computing component VaRs for distributions that are not elliptical. The procedure is to sort the historical returns of the portfolio and designate a portfolio return that corresponds to the loss associated with the VaR and then find the returns of each of the components associated with that portfolio loss. Those position returns can be used to compute component VaRs.

LO 67.2

For a two-asset portfolio, two special cases are:

1. VaR for uncorrelated positions:
   $\text{VaR}_P = \sqrt{\text{VaR}_1^2 + \text{VaR}_2^2}$

2. VaR for perfectly correlated positions:
   $\text{Undiversified VaR} = \text{VaR}_P = \sqrt{\text{VaR}_1^2 + \text{VaR}_2^2 + 2\text{VaR}_1\text{VaR}_2} = \text{VaR}_1 + \text{VaR}_2$

LO 67.3

The incremental VaR is the difference between the new VaR from the revaluation minus the VaR before the addition. The revaluation requires not only measuring the risk of the position itself, but it also requires measuring the change in the risk of the other positions that are already in the portfolio. For a portfolio with hundreds or thousands of positions, this would be time consuming.

LO 67.4

Portfolio risk will be at a global minimum where all the marginal VaRs are equal for all i and j:

$$\text{MVaR}_i = \text{MVaR}_j$$

LO 67.5

Equating the MVaRs will obtain the portfolio with the lowest portfolio VaR. Equating the excess return/MVaR ratios will obtain the optimal portfolio.

LO 67.6

The optimal portfolio is the one for which all excess-return-to-marginal VaR ratios are equal:

$$\frac{(\text{Position i return} - \text{risk-free rate})}{(\text{MVaR}_i)} = \frac{(\text{Position j return} - \text{risk-free rate})}{(\text{MVaR}_j)}$$

Concept Checkers

1. Which of the following is the best synonym for diversified VaR?
   A. Vector VaR.
   B. Position VaR.
   C. Portfolio VaR.
   D. Incidental VaR.

2. When computing individual VaR, it is proper to:
   A. use the absolute value of the portfolio weight.
   B. use only positive weights.
   C. use only negative weights.
   D. compute VaR for each asset within the portfolio.

3. A portfolio consists of two positions. The VaR of the two positions are $10 million and $20 million. If the returns of the two positions are not correlated, the VaR of the portfolio would be closest to:
   A. $5.48 million.
   B. $15.00 million
   C. $22.36 million.
   D. $25.00 million.

4. Which of the following is true with respect to computing incremental VaR? Compared to using marginal VaRs, computing with full revaluation is:
   A. more costly, but less accurate.
   B. less costly, but more accurate.
   C. less costly, but also less accurate.
   D. more costly, but also more accurate.

5. A portfolio has an equal amount invested in two positions, X and Y. The expected excess return of X is 9% and that of Y is 12%. Their marginal VaRs are 0.06 and 0.075, respectively. To move toward the optimal portfolio, the manager will probably:
   A. increase the allocation in Y and/or lower that in X.
   B. increase the allocation in X and/or lower that in Y.
   C. do nothing because the information is insufficient.
   D. not change the portfolio because it is already optimal.

Concept Checker Answers

1. **C** Portfolio VaR should include the effects of diversification. None of the other answers are types of VaRs.

2. **A** The expression for individual VaR is $VaR_i = Z_c \times \sigma \times |P_i| = Z \times \sigma_i \times |w_i| \times P$. The absolute value signs indicate that we need to measure the risk of both positive and negative positions, and risk cannot be negative.

3. **C** For uncorrelated positions, the answer is the square root of the sum of the squared VaRs:

$$VaR_P = \sqrt{(10^2 + 20^2)} \times (\$ \text{ million}) = \$22.36 \text{ million}.$$

4. **D** Full revaluation means recalculating the VaR of the entire portfolio. The marginal VaRs are probably already known, so using them is probably less costly, but will not be as accurate.

5. **A** The expected excess-return-to-MVaR ratios for X and Y are 1.5 and 1.6, respectively. Therefore, the portfolio weight in Y should increase to move the portfolio toward the optimal portfolio.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

VaR and Risk Budgeting in Investment Management

Topic 68

Exam Focus

Banks on the "sell side" of the investment industry have long used risk budgeting and value at risk (VaR). There is a trend for the "buy side" investment firms to increasingly use VaR. One reason for increased demand for risk budgeting is the increased complexity, dynamics, and globalization of the investment industry. Use of VaR can help set better guidelines than more traditional limits. By measuring marginal and incremental VaRs, a manager can make better decisions concerning portfolio weights. For the exam, be comfortable with the concept of surplus at risk (SaR). Also, understand how to budget risk across asset classes and active managers.

Risk Budgeting

LO 68.1: Define risk budgeting.

Risk budgeting is a top-down process that involves choosing and managing exposures to risk. The main idea is that the risk manager establishes a risk budget for the entire portfolio and then allocates risk to individual positions based on a predetermined fund risk level. The risk budgeting process differs from market value allocation since it involves the allocation of risk.

Managing Risk With VaR

LO 68.2: Describe the impact of horizon, turnover, and leverage on the risk management process in the investment management industry.

The "sell side" of the investment industry largely consists of banks that have developed VaR techniques and have used them for many years. Investors make up the "buy side" of the investment industry. Investors are now using VaR techniques, but they have to adapt them to the different nature of that side of the business. To understand why the needs are different, we should compare the characteristics of the two "sides." Figure 1 makes direct comparisons.

Figure 1: Sell Side and Buy Side Characteristics

Characteristic	*Sell Side*	*Buy Side*
Horizon	Short-term (days)	Long-term (month or more)
Turnover	Fast	Slow
Leverage	High	Low
Risk measures	VaR Stress tests	Asset allocation Tracking error
Risk controls	Position limits VaR limits Stop-loss rules	Diversification Benchmarking Investment guidelines

Banks trade rapidly, which is why they cannot rely on traditional measures of risk that are based on historical data. For banks, yesterday's risk may not have anything to do with today's positions. Investors usually try to hold positions for longer periods of time (e.g., years).

Having a more dynamic method for measuring risk such as VaR is also important for banks because of their high leverage. Institutional investors often have much stronger constraints with respect to leverage; therefore, they have a much lower need to control downside risk.

The Investment Process

LO 68.3: Describe the investment process of large investors such as pension funds.

The *first step* in the investment process is to determine the long-term, strategic asset allocations. Usually, the goal of the first step is to balance returns and risks using methods like mean-variance portfolio optimization. This step determines the allocations to asset classes such as domestic and foreign stocks, domestic and foreign bonds, and alternative investments such as real estate, venture capital, and hedge funds. Making this allocation relies on passive indices and other benchmarks to help measure the properties of the investment, and the availability of passive indices helps make the allocations feasible.

The *second step* in the investment process is to choose the managers who may either passively manage the fund (i.e., simply track the benchmarks) or actively manage the fund in an effort to outperform the benchmarks. The investors should review the managers' activities and performance periodically. Their activities should conform to a list of guidelines, which includes the types of investments and risk exposure restrictions such as beta and duration. Managers' performance can be evaluated by analyzing their tracking error.

VaR risk management systems are beginning to become more important because of the globalization of available investments and the increased complexity of investments. Also, investment companies are becoming more dynamic, which makes it more difficult to assess risk. With many managers, for example, each of the managers may make changes within his constraints, but the collective changes could be difficult to gauge with historical measures. In sum, because of increased globalization, complexity, and the dynamic nature of the investment industry, simply measuring risk using historical measures is no longer adequate, which has increased the need for VaR.

Hedge Fund Issues

LO 68.4: Describe the risk management challenges associated with investments in hedge funds.

Hedge funds are a very heterogeneous class of assets that include a variety of trading strategies. Since they often use leverage and trade a great deal, their risk characteristics may be more similar to the "sell side" of the industry. Hedge funds have some other risks like liquidity and low transparency. Liquidity risk has many facets. First, there is the obvious potential loss from having to liquidate too quickly. Second, there is the difficulty of measuring the exact value of the fund to be able to ascertain its risk. Furthermore, the low liquidity tends to lower the volatility of historical prices as well as the correlations of the positions. These properties will lead to an underestimation of traditional measures of risk. In addition to these risks, there is the low level of transparency. This makes the risk measurement difficult with respect to both the size and type. Not knowing the type of risk increases the difficulty of risk management for the entire portfolio in which an investor might include hedge funds.

Absolute vs. Relative Risk and Policy Mix vs. Active Risk

LO 68.5: Distinguish among the following types of risk: absolute risk, relative risk, policy-mix risk, active management risk, funding risk, and sponsor risk.

Absolute or asset risk refers to the total possible losses over a horizon. It is simply measured by the return over the horizon. **Relative risk** is measured by excess return, which is the dollar loss relative to a benchmark. The shortfall is measured as the difference between the fund return and that of a benchmark in dollar terms. VaR techniques can apply to tracking error (i.e., standard deviation of excess return) if the excess return is normally distributed.

Professor's Note: The author's definition of tracking error differs from the definition of tracking error in other assigned readings. Jorion defines tracking error as active return minus the benchmark return. In other readings, this value is simply the excess return and tracking error is the volatility (i.e., standard deviation) of the excess return. Throughout this topic, we have expressed excess return as portfolio return minus benchmark return and tracking error as the volatility of the excess return. This methodology follows the definition of tracking error on previous FRM exams.

Distinguishing **policy mix** from **active risk** is important when an investment firm allocates funds to different managers in various asset classes. This breaks down the risk of the total portfolio into that associated with the target policy (i.e., the weights assigned to the various funds in the policy) and the risk from the fact that managers may make decisions which lead to deviations from the designated weights. VaR analysis is especially useful here because it can show the risk exposure associated with the two types of risk and how they affect the overall risk of the entire portfolio. Often, active management risk is not much of a problem for several reasons:

- For well-managed funds, it is usually fairly small for each of the individual funds.

- There will be diversification effects across the deviations.
- There can be diversification effects with the policy mix VaR to actually lower the total portfolio VaR.

Funding Risk

Funding risk refers to being able to meet the obligations of an investment company (e.g., a pension's payout to retirees). Put another way, funding risk is the risk that the value of assets will not be sufficient to cover the liabilities of the fund. The level of funding risk varies dramatically across different types of investment companies. Some have zero, while defined benefit pension plans have the highest.

The focus of this analysis is the surplus, which is the difference between the value of the assets and the liabilities, and the change in the surplus, which is the difference between the change in the assets and liabilities:

$$\text{Surplus} = \text{Assets} - \text{Liabilities}$$

$$\Delta\text{Surplus} = \Delta\text{Assets} - \Delta\text{Liabilities}$$

Typically, in managing funding risk, an analyst will transform the nominal return on the surplus into a return on the assets, and break down the return as indicated:

$$R_{surplus} = \frac{\Delta Surplus}{Assets} = \frac{\Delta Assets}{Assets} - \left(\frac{\Delta Liabilities}{Liabilities}\right)\left(\frac{Liabilities}{Assets}\right) = R_{asset} - R_{liabilities}\left(\frac{Liabilities}{Assets}\right)$$

Evaluating this expression requires assumptions about the liabilities, which are in the future and uncertain. For pension funds, liabilities represent "accumulated benefit obligations," which are the present value of pension benefits owed to the employees and other beneficiaries. Determining the present value requires a discount rate, which is usually tied to some current level of interest rates in the market. An ironic aspect of funding risk is that assets for meeting the obligations like equities and bonds usually increase in value when interest rates decline, but the present value of future obligations may increase even more. When assets and liabilities change by different amounts, this affects the surplus, and the resulting volatility of the surplus is a source of risk. If the surplus turns negative, additional contributions will be required. This is called **surplus at risk** (SaR).

One answer to this problem is to immunize the portfolio by making the duration of the assets equal that of the liabilities. This may not be possible since the necessary investments may not be available, and it may not be desirable because it may mean choosing assets with a lower return.

Example: Determining a fund's risk profile

The XYZ Retirement Fund has $200 million in assets and $180 million in liabilities. Assume that the expected return on the surplus, scaled by assets, is 4%. This means the surplus is expected to grow by $8 million over the first year. The volatility of the surplus is 10%. Using a Z-score of 1.65, **compute** VaR and the associated deficit that would occur with the loss associated with the VaR.

Answer:

First, we calculate the expected value of the surplus. The current surplus is $20 million (= $200 million – $180 million). It is expected to grow another $8 million to a value of $28 million. As for the VaR:

VaR = (1.65)(10%)($200 million) = $33 million

If this decline in value occurs, the deficit would be the difference between the VaR and the expected surplus value: $33 million – $28 million = $5 million.

Professor's Note: According to the assigned reading, the surplus at risk (SaR) is the VaR amount calculated previously. Note that SaR on previous exams has been approached differently, as illustrated in the following example. Be prepared for either approach on the actual exam. In the example to follow, we will illustrate how to calculate the volatility of surplus growth. On previous FRM exams, this value has not been provided.

Example: Surplus at risk (via computing volatility of surplus)

The XYZ Retirement Fund has $200 million in assets and $180 million in liabilities. Assume that the expected annual return on the assets is 4% and the expected annual growth of the liabilities is 3%. Also assume that the volatility of the asset return is 10% and the volatility of the liability growth is 7%. **Compute** 95% surplus at risk assuming the correlation between asset return and liability growth is 0.4.

Answer:

First, compute the expected surplus growth:

200 × (0.04) – 180 × (0.03) = $2.6 million

Next, compute the volatility of the surplus growth. To compute the volatility you need to recall one of the properties of covariance discussed in the FRM Part I curriculum. The variance of assets minus liabilities [i.e., Var(A-L)] = Var(A) + Var(L) – 2 × Cov(A,L). Where covariance is equal to the standard deviation of assets times the standard deviation of liabilities times the correlation between the two. The asset and liability amounts will also need to be applied to this formula.

$$\text{Variance(A-L)} = 200^2 \times 0.10^2 + 180^2 \times 0.07^2 - 2 \times 200 \times 180 \times 0.10 \times 0.07 \times 0.4$$

$$= 400 + 158.76 - 201.6 = \$357.16 \text{ million}$$

$$\text{Standard deviation} = \sqrt{357.16} = \$18.89$$

Thus, SaR can be calculated by incorporating the expected surplus growth and standard deviation of the growth.

$$95\% \text{ SaR} = 2.6 - 1.65 \times 18.89 = \$28.57 \text{ million}$$

Professor's Note: Like VaR, SaR is a negative value since it is the surplus amount that is at risk. As a result, the negative sign is usually not presented since a negative amount is implied.

Plan Sponsor Risk

The plan sponsor risk is an extension of surplus risk and how it relates to those who ultimately bear responsibility for the pension fund. We can distinguish between the following risk measures:

- **Economic risk** is the variation in the total economic earnings of the plan sponsor. This takes into account how the risks of the various components relate to each other (e.g., the correlation between the surplus and operating profits).
- **Cash-flow risk** is the variation of contributions to the fund. Being able to absorb fluctuations in cash flow allows for a more volatile risk profile.

Ultimately, from the viewpoint of the sponsor, the focus should be on the variation of the economic value of the firm. The management should integrate the various risks associated with the movement of the assets and surplus with the overall financial goals of the sponsor. This is aligned with the current emphasis on enterprise-wide risk management.

Monitoring Risk With VaR

LO 68.6: Apply VaR to check compliance, monitor risk budgets, and reverse engineer sources of risk.

There are many types of risks that can increase dramatically in a large firm. For example, the "rogue trader" phenomenon is more likely in a large firm. This occurs when a manager of one of the accounts or funds within the larger portfolio deviates from her guidelines

in terms of portfolio weights or even trades in unauthorized investments. Such deviations from compliance can be very short-term, and regular reporting measures may not catch the violations.

Risk management is necessary for all types of portfolios—even passively managed portfolios. Some analysts erroneously believe that passive investing, or benchmarking, does not require risk monitoring. This is not true because the risk profiles of the benchmarks change over time. In the late 1990s, a portfolio benchmarked to the S&P 500 would clearly have seen a change in risk exposures (e.g., an increase in the exposure to risks associated with the high-tech industry). A forward-looking risk measurement system would pick up on such trends.

Monitoring the risk of actively managed portfolios should help identify the reasons for changes in risk. Three explanations for dramatic changes in risk are (1) a manager taking on more risk, (2) different managers taking similar bets, and (3) more volatile markets. Thus, when there is an increase in the overall risk of a portfolio, top management would want to investigate the increase by asking the following questions.

Has the manager exceeded her risk budget? VaR procedures and risk management can allocate a risk budget to each manager. The procedures should give an indication if and why the manager exceeds the risk budget. Is it a temporary change from changes in the market? Has the manager unintentionally let the weights of the portfolio drift so as to increase risk? Or, more seriously, has the manager engaged in unauthorized trades?

Are managers taking too many of the same style bets? If the managers are acting independently, it is possible that they all start pursuing strategies with the same risk exposures. This could happen, for example, if all managers forecast lower interest rates. Bond managers would probably begin moving into long-term bonds, and equity managers would probably begin moving into stocks that pay a high and stable dividend like utility companies and REITs. This would drastically increase the interest rate risk of the overall portfolio.

Have markets become more volatile? If the risk characteristics of the entire market have changed, top management will have to decide if it is worth accepting the volatility or make decisions to reduce it by changing the target portfolio weights.

VaR can also be reverse engineered by utilizing the VaR tools outlined in the previous topic, such as component VaR and marginal VaR. These tools provide insight on how the overall portfolio will be affected by individual position changes. This method can be used provided that all relevant risks have been identified within the risk management system.

In the risk management process, there is a problem with measuring the risk of some unique asset classes like real estate, hedge funds, and venture capital. Also, there may be limited information on investments in a certain class (e.g., emerging markets and initial public offerings).

There is a trend in the investment industry toward management choosing a **global custodian** for the firm. Such a choice means an investor aggregates the portfolios with a single custodian, which more easily allows a consolidated picture of the total exposures of the fund. The custodian can combine reports on changes in positions with market data to produce forward-looking risk measures. Thus, the global custodian is an easy choice in pursuing centralized risk management. Along with the trend toward global custodians,

there has been a trend in the "custodian industry" toward fewer custodians that can provide more services. Large custodian banks such as Citibank, Deutsche Bank, and State Street are providing risk management products.

Those that choose not to use a global custodian have done so because they feel that they have a tighter control over risk measures and can better incorporate VaR systems into operations. There are often economies of scale for larger firms in that they can spread the cost of risk management systems over a large asset base. Also, they can require tighter control when their assets are partly managed internally.

Increasingly, clients are asking money managers about their risk management systems. The clients are no longer satisfied with quarterly performance reports. Many investment managers have already incorporated VaR systems into their investment management process. Widely used risk standards for institutional investors recommend measuring the risk of the overall portfolio and measuring the risk of each instrument. It may be the case that those who do not have comprehensive risk management systems will soon be at a significant disadvantage to those who do have such systems. There also seems to be some attempt by managers to differentiate themselves with respect to risk management.

VaR Applications

LO 68.7: Explain how VaR can be used in the investment process and the development of investment guidelines.

Investment Guidelines

VaR can help move away from the ad hoc nature and overemphasis on notionals and sensitivities that characterize the guidelines many managers now use. Clearly, ad hoc procedures will generally be inferior to formal guidelines using established principles. Also, limits on notionals and sensitivities have proven insufficient when leverage and positions in derivatives exist. The limits do not account for variations in risk nor correlations. VaR limits include all of these factors.

The problem with controlling positions and not risk is that there are many rules and restrictions, which in the end may not achieve the main goal. There is no measure of the possible losses that can occur in a given time period—a good quantity to identify in order to know how much capital to have on hand to meet liquidity needs. Furthermore, simple restrictions on certain positions can be easily evaded with the many instruments that are now available. As a wider range of products develop, obviously, the traditional and cumbersome position-by-position guidelines will become even less effective.

Investment Process

VaR can help in the first step of the investment process, which is the strategic asset-allocation decision. Since this step usually uses mean-variance analysis, as does the most basic VaR measures, VaR can help in the portfolio allocation process. Furthermore, VaR can

measure specific changes in risk that can result as managers subjectively adjust the weights from those recommended by pure quantitative analysis.

VaR is also useful at the trading level. A trader usually focuses on the return and stand-alone risk of a proposed position. The trader may have some idea of how the risk of the position will affect the overall portfolio, but an adequate risk management system that uses VaR can give a specific estimate of the change in risk. In fact, the risk management system should stand ready to automatically calculate the marginal VaR of each existing position and proposed position. When the trader has the choice between adding one of two positions with similar return characteristics, the trader would choose the one with the lower marginal VaR. VaR methodology can help make choices between different assets too. The optimal portfolio will be the one that has the excess-return-to-marginal VaR ratios equal for all asset types, as seen in the previous topic. Thus, when a trader is searching for the next best investment, the trader will look at securities in the asset classes that currently have the higher returns-to-marginal-VaR ratios.

Budgeting Risk

LO 68.8: Describe the risk budgeting process and calculate risk budgets across asset classes and active managers.

Risk budgeting should be a top down process. The first step is to determine the total amount of risk, as measured by VaR, that the firm is willing to accept. The next step is to choose the optimal allocation of assets for that risk exposure. As an example, a firm's management might set a return volatility target equal to 20%. If the firm has $100 million in assets under management and assuming the returns are normally distributed, at a 95% confidence level, this translates to:

$$\text{VaR} = (1.65) \times (20\%) \times (\$100 \text{ million}) = \$33 \text{ million}$$

The goal will be to choose assets for the fund that keep VaR less than this value. Unless the asset classes are perfectly correlated, the sum of the VaRs of the individual assets will be greater than the actual VaR of the portfolio. Thus, the budgeting of risk across asset classes should take into account the diversification effects. Such effects can be carried down to the next level when selecting the individual assets for the different classes.

Example: Budgeting risk across asset classes (part 1)

A manager has a portfolio with only one position: a $500 million investment in W. The manager is considering adding a $500 million position X or Y to the portfolio. The current volatility of W is 10%. The manager wants to limit portfolio VaR to $200 million at the 99% confidence level. Position X has a return volatility of 9% and a correlation with W equal to 0.7. Position Y has a return volatility of 12% and a correlation with W equal to zero. **Determine** which of the two proposed additions, X or Y, will keep the manager within his risk budget.

Answer:

Currently, the VaR of the portfolio with only W is:

$$VaR_W = (2.33)(10\%)(\$500 \text{ million}) = \$116.5 \text{ million}$$

When adding X, the return volatility of the portfolio will be:

$$8.76\% = \sqrt{(0.5^2)(10\%)^2 + (0.5^2)(9\%)^2 + (2)(0.5)(0.5)(0.7)(10\%)(9\%)}$$

$$VaR_{W+X} = 2.33(8.76\%)(\$1{,}000 \text{ million}) = \$204 \text{ million}$$

When adding Y, the return volatility of the portfolio will be:

$$7.81\% = \sqrt{(0.5^2)(10\%)^2 + (0.5^2)(12\%)^2}$$

$$VaR_{W+Y} = (2.33)(7.81\%)(\$1{,}000 \text{ million}) = \$182 \text{ million}$$

Thus, Y keeps the total portfolio within the risk budget.

Example: Budgeting risk across asset classes (part 2)

In the previous example, **demonstrate** why focusing on the stand-alone VaR of X and Y would have led to the wrong choice.

Answer:

Obviously, the VaR of X is less than that of Y.

$$VaR_X = (2.33)(9\%)(\$500 \text{ million}) = \$104.9 \text{ million}$$

$$VaR_Y = (2.33)(12\%)(\$500 \text{ million}) = \$139.8 \text{ million}$$

The individual VaRs would have led the manager to select X over Y; however, the high correlation of X with W gives X a higher incremental VaR, which puts the portfolio of W and X over the limit. The zero correlation of W and Y makes the incremental VaR of Y much lower, and the portfolio of W with Y keeps the risk within the limit.

The traditional method for evaluating active managers is by measuring their excess return and tracking error and using it to derive a measure known as the information ratio. Excess return is the active return minus the benchmark return. The **information ratio** of manager *i* is:

$$IR_i = \frac{\text{(expected excess return of the manager)}}{\text{(the manager's tracking error)}}$$

For a portfolio of funds, each managed by a separate manager, the top management of the entire portfolio would be interested in the portfolio information ratio:

$$IR_P = \frac{\text{(expected excess return of the portfolio)}}{\text{(the portfolio's tracking error)}}$$

If the excess returns of the managers are independent of each other, it can be shown that the optimal allocation across managers is found by allocating weights to managers according to the following formula:

$$\text{weight of portfolio managed by manager } i = \frac{IR_i \times (\text{portfolio's tracking error})}{IR_P \times (\text{manager's tracking error})}$$

One way to use this measure is to "budget" portfolio tracking error. Given the IR_p, the IR_i, and the manager's tracking error, top management can calculate the respective weights to assign to each manager. The weights of the allocations to the managers do not necessarily have to sum to one. Any difference can be allocated to the benchmark itself because, by definition, $IR_{benchmark} = 0$.

Determining the precise weights will be an iterative process in that each selection of weights will give a different portfolio expected excess return and tracking error. Figure 2 illustrates a set of weights derived from the given inputs that satisfy the condition.

Figure 2: Budgeting Risk Across Active Managers

	Tracking Error	*Information Ratio*	*Weights*
Manager A	5.0%	0.70	51%
Manager B	5.0%	0.50	37%
Benchmark	0.0%	0.00	12%
Portfolio	3.0%	0.82	100%

Although we have skipped the derivation, we can see that the conditions for optimal allocation hold true:

$$\text{For A: } 51\% = \frac{(3\%)(0.70)}{(5\%)(0.82)}$$

$$\text{For B: } 37\% = \frac{(3\%)(0.50)}{(5\%)(0.82)}$$

The difference between 100% and the sum of the weights 51% and 37% is the 12% invested in the benchmark.

Key Concepts

LO 68.1

Risk budgeting is a top-down process that involves choosing and managing exposures to risk.

LO 68.2

Compared to banks on the "sell side," investors on the "buy side" have a longer horizon, slower turnover, and lower leverage. They have tended to use historical risk measures and focus on tracking error, benchmarking, and investment guidelines. Banks use forward-looking VaR risk measures and VaR limits. Investors seem to be using VaR more and more, but they have to adapt it to their needs.

LO 68.3

Investors are relying more on VaR because of increased globalization, complexity, and dynamics of the investment industry. They have found simply measuring risk from historical measures is no longer adequate.

LO 68.4

Hedge funds have risk characteristics that make them more similar to the "sell side" of the industry like the use of leverage and high turnover. In addition to that, they have other risks such as low liquidity and low transparency. Low liquidity leads to problems in measuring risk because it tends to put a downward bias on volatility and correlation measures.

LO 68.5

Absolute or asset risk refers to the total possible losses over a horizon. Relative risk is measured by excess return, which is the dollar loss relative to a benchmark. VaR measures can apply to both.

The risk from the policy mix is from the chosen portfolio weights, and active risk is from individual managers deviating from the chosen portfolio weights.

Funding risk is the risk that the value of assets will not be sufficient to cover the liabilities of the fund. It is important for pension funds. In applying VaR, a manager will add the expected increase in the surplus to the surplus and subtract the VaR of the assets from it. The difference between the expected surplus and the portfolio VaR is the shortfall associated with the VaR.

Two components of sponsor risk are cash-flow risk, which addresses variations of contributions to the fund, and economic risk, which is the variation of the earnings.

LO 68.6

Risk monitoring is important in large firms to catch "rogue traders" whose activities may go undetected with simple periodic statements. It is also needed for passive portfolios because the risk characteristics of the benchmarks can change. Risk monitoring can also determine why changes in risk have occurred (e.g., individual managers exceeding their budget, different managers taking on the same exposures, or the risk characteristics of the whole market changing).

There is a trend toward using a global custodian in the risk management of investment firms. It is an easy means to the goal of centralized risk management. The custodians can combine reports on changes in positions with market data to produce forward-looking risk measures. Those that choose not to use a global custodian have done so because they feel they have tighter control over risk measures and can better incorporate VaR systems into operations.

LO 68.7

There is a trend of investment managers incorporating VaR systems into their investment management process. There is evidence that money managers are differentiating themselves with respect to their risk management systems, and those that do not use such systems are at a competitive disadvantage.

VaR techniques can help move away from the ad hoc nature and overemphasis on notionals and sensitivities that characterize the guidelines many managers now use. Such guidelines are cumbersome and ineffective in that they focus on individual positions and can be easily circumvented.

VaR is useful for the investment process. When a trader has a choice between two new positions for a portfolio, the trader can compare the marginal VaRs to make the selection. When deciding whether to increase one existing position over another, the trader can compare the excess-return-to-MVaR ratios and increase the position in the one with the higher ratio.

LO 68.8

Budgeting risk across asset classes means selecting assets whose combined VaRs are less than the total allowed. The budgeting process would examine the contribution each position makes to the portfolio VaR.

For allocating across active managers, it can be shown that the optimal allocation is achieved with the following formula:

$$\text{weight of portfolio managed by manager } i = \frac{IR_i \times (\text{portfolio's tracking error})}{IR_P \times (\text{manager's tracking error})}$$

For a given group of active managers, the weights may not sum to one. The remainder of the weight can be allocated to the benchmark, which has no tracking error.

Concept Checkers

1. With respect to the buy side and sell side of the investment industry:

   I. the buy side uses more leverage.
   II. the sell side has relied more on VaR measures.

   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

2. Compared to policy risk, which of the following is not a reason that management risk is not much of a problem?
   A. There will be diversification effects across the deviations.
   B. Managers tend to make the same style shifts at the same time.
   C. For well-managed funds, it is usually fairly small for each of the individual funds.
   D. There can be diversification with the policy mix VaR to actually lower the total portfolio VaR.

3. Using VaR to monitor risk is important for a large firm with many types of managers because:
   A. it can help catch rogue traders and it can detect changes in risk from changes in benchmark characteristics.
   B. although it cannot help catch rogue traders, it can detect changes in risk from changes in benchmark characteristics.
   C. although it cannot detect changes in risk from changes in benchmark characteristics, it can help detect rogue traders.
   D. of no reason. VaR is not useful for monitoring risk in large firms.

4. VaR can be used to compose better guidelines for investment companies by:

   I. relying less on notionals.
   II. focusing more on overall risk.

   A. I only.
   B. II only
   C. Both I and II.
   D. Neither I nor II.

5. In making allocations across active managers, which of the following represents the formula that gives the optimal weight to allocate to a manager denoted *i*, where IR_i and IR_P are the information ratios of the manager and the total portfolio respectively?

A. $\frac{IR_P \times (\text{portfolio's tracking error})}{IR_i \times (\text{manager's tracking error})}$.

B. $\frac{IR_i \times (\text{manager's tracking error})}{IR_P \times (\text{portfolio's tracking error})}$.

C. $\frac{IR_i \times (\text{portfolio's tracking error})}{IR_P \times (\text{manager's tracking error})}$.

D. $\frac{IR_P \times (\text{manager's tracking error})}{IR_i \times (\text{portfolio's tracking error})}$.

Concept Checker Answers

1. **B** Compared to banks on the "sell side," investors on the "buy side" have a longer horizon, slower turnover, and lower leverage. Banks use forward-looking VaR risk measures and VaR limits.

2. **B** If managers make the same style shifts, then that would actually increase management risk. All the other reasons are valid.

3. **A** Both of these are reasons large firms find VaR and risk monitoring useful.

4. **C** Investment companies have been focusing on limits on notionals, which is cumbersome and has proved to be ineffective.

5. **C** weight of portfolio managed by manager $i = \dfrac{IR_i \times (\text{portfolio's tracking error})}{IR_P \times (\text{manager's tracking error})}$

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Risk Monitoring and Performance Measurement

Topic 69

Exam Focus

Most of this topic is qualitative in nature, however, it does contain several testable concepts. Many of the concepts covered here are also covered in other assigned readings, so this topic should serve as reinforcement of those concepts. For the exam, focus on the three pillars of effective risk management: planning, budgeting, and monitoring. Understand the concept of a risk management unit (RMU) and be able to discuss its appropriate role within a company. Always keep in mind while reviewing this topic that it is the amount of risk taken that ultimately drives the level of returns—risk is the "cost" of returns.

Risk Measures

LO 69.1: Define, compare, and contrast VaR and tracking error as risk measures.

Value at risk (VaR) is defined to be the *largest* loss possible for a *certain* level of confidence over a *specific* period of time. For example, a firm could express its VaR as being 95% certain that they will lose a maximum of $5 million in the next ten days. Delta-normal VaR assumes a normal distribution, and its calculation reflects losses in the lower tail of the returns distribution.

Tracking error is defined as the standard deviation of excess returns. Excess return is defined as the portfolio return less the benchmark return (i.e., alpha). Assuming a normal distribution of excess returns, 95% of the outcomes will fall within the mean benchmark return plus or minus roughly two standard deviations.

VaR and tracking error are both measures of risk. An organization's objective is to maximize profits for a given level of risk taken. Too much risk taken (in comparison with budget) suggests a VaR level that is too high and a willingness to accept large losses to produce unnecessarily high returns. Too little risk taken suggests that there is not enough active management, and actual returns will fall short of budgeted returns.

VaR may be used to suggest the maximum dollar value of losses for a specific level of confidence over a specific time. From a portfolio management perspective, VaR could be determined for each asset class, and capital allocation decisions could be made amongst the asset classes depending on risk and return preferences. This will help to achieve targeted levels of dollar VaR. In contrast, tracking error may be used to determine the relative amount of discretion that can be taken by the portfolio manager (away from benchmark returns) in his or her attempts at active management.

Risk Planning

LO 69.2: Describe risk planning, including its objectives, effects, and the participants in its development.

There are five risk planning objectives for any entity to consider.

1. Setting expected return and expected volatility goals.

   Examples of an entity's goals could include specifying the acceptable amounts of VaR and tracking error for a given period of time. Scenario analysis could be employed to determine potential sources of failure in the plan as well as ways to respond should those sources occur.

2. Defining quantitative measures of success or failure.

   Specific guidelines should be stated. For example, one could state an acceptable level of return on equity (ROE) or return on risk capital (RORC). This would help regulatory agencies assess the entity's success or failure from a risk management perspective.

3. Generalizing how risk capital will be utilized to meet the entity's objectives.

   Objectives relating to return per unit of risk capital need to be defined. For example, the minimum acceptable RORC should be defined for each activity where risk is allocated from the budget. The correlations between the RORCs should also be considered within an entity-wide risk diversification context.

4. Defining the difference between events that cause ordinary damage versus serious damage.

   Specific steps need to be formulated to counter any event that threatens the overall long-term existence of the entity, even if the likelihood of occurrence is remote. The choice between seeking external insurance (i.e., put options) versus self-insurance for downside portfolio risk has to be considered from a cost-benefit perspective, taking into account the potential severity of the losses.

5. Identifying mission critical resources inside and outside the entity and discussing what should be done in case those resources are jeopardized.

   Examples of such resources would include key employees and financing sources. Scenario analysis should be employed to assess the impact on those resources in both good and bad times. Specifically, adverse events often occur together with other adverse (and material) events.

In general, the risk planning process frequently requires the input and approval of the entity's owners and its management team. An effective plan requires very active input from the entity's highest level of management so as to ensure risk and return issues are addressed, understood, and communicated within the entity, to key stakeholders, and to regulatory agencies.

Risk Budgeting

LO 69.3: Describe risk budgeting and the role of quantitative methods in risk budgeting.

The risk budget quantifies the risk plan. There needs to be a structured budgeting process to allocate risk capital to meet the entity's objectives and minimize deviations from the plan. Each specific allocation from the risk budget comes with a reasonable return expectation. The return expectation comes with an estimate of variability around that expectation.

With risk budgets, an amount of VaR could be calculated for each item on the income statement. This allows RORC to be calculated individually and in aggregate.

Quantitative methods (i.e., mathematical modeling) may be used in risk budgeting as follows:

1. Set the minimum acceptable levels of RORC and ROE over various time periods. This is to determine if there is sufficient compensation for the risks taken (i.e., risk-adjusted profitability).

2. Apply mean-variance optimization (or other quantitative methods) to determine the weights for each asset class.

3. Simulate the portfolio performance based on the weights and for several time periods. Apply sensitivity analysis to the performance by considering changes in estimates of returns and covariances.

Risk Monitoring

LO 69.4: Describe risk monitoring and its role in an internal control environment.

Within an entity's internal control environment, risk monitoring attempts to seek and investigate any significant variances from budget. This is to ensure, for example, that there are no threats to meeting its ROE and RORC targets. Risk monitoring is useful in that it should detect and address any significant variances in a timely manner.

LO 69.5: Identify sources of risk consciousness within an organization.

The increasing sense of risk consciousness within and among organizations is mainly derived from the following three sources:

1. *Banks* who lend funds to investors are concerned with where those funds are invested.

2. *Boards of investment clients, senior management, and plan sponsors* have generally become more versed in risk management issues and more aware of the need for effective oversight over asset management activities.

3. *Investors* have become more knowledgeable about their investment choices. For example, beneficiaries of a defined contribution plan are responsible for selecting their individual pension investments.

LO 69.6: Describe the objectives and actions of a risk management unit in an investment management firm.

A **risk management unit** (RMU) monitors an investment management entity's portfolio risk exposure and ascertains that the exposures are authorized and consistent with the risk budgets previously set. To ensure proper segregation of duties, it is crucial that the risk management function has an independent reporting line to senior management.

The objectives of a RMU include:

- Gathering, monitoring, analyzing, and distributing risk data to managers, clients, and senior management. Accurate and relevant information must be provided to the appropriate person(s) at the appropriate time(s).
- Assisting the entity in formulating a systematic and rigorous method as to how risks are identified and dealt with. Promotion of the entity's risk culture and best risk practices is crucial here.
- Going beyond merely providing information by taking the initiative to research relevant risk topics that will affect the firm.
- Monitoring trends in risk on a continual basis and promptly reporting unusual events to management before they become significant problems.
- Promoting discussion throughout the entity and developing a process as to how risk data and issues are discussed and implemented within the entity.
- Promoting a greater sense of risk awareness (culture) within the entity.
- Ensuring that transactions that are authorized are consistent with guidance provided to management and with client expectations.
- Identifying and developing risk measurement and performance attribution analytical tools.
- Gathering risk data to be analyzed in making portfolio manager assessments and market environment assessments.
- Providing the management team with information to better comprehend risk in individual portfolios as well as the source of performance.
- Measuring risk within an entity. In other words, measuring how consistent portfolio managers are with respect to product objectives, management expectations, and client objectives. Significant deviations are brought to the attention of appropriate management to provide a basis for correction.

Professor's Note: You may see references elsewhere to an Independent Risk Oversight Unit. This is the same concept as RMU. Both measure and manage risk exposure and operate as an independent business unit.

LO 69.7: Describe how risk monitoring can confirm that investment activities are consistent with expectations.

Is the manager generating a forecasted level of tracking error that is consistent with the target?

The forecasted tracking error is an approximation of the potential risk of a portfolio using statistical methods. For each portfolio, the forecast should be compared to budget using predetermined guidelines as to how much variance is acceptable, how much variance requires further investigation, and how much variance requires immediate action. Presumably, the budget was formulated taking into account client expectations.

Tracking error forecast reports should be produced for all accounts that are managed similarly in order to gauge the consistency in risk levels taken by the portfolio manager.

Is risk capital allocated to the expected areas?

Overall tracking risk is not sufficient as a measure on its own; it is important to break down the tracking risk into "subsections." If the analysis of the risk taken per subsection does not suggest that risk is being incurred in accordance with expectations, then there may be **style drift**. Style drift may manifest itself in a value portfolio manager who attains the overall tracking error target but allocates most of the risk (and invests) in growth investments.

Therefore, by engaging in risk decomposition, the RMU may ensure that a portfolio manager's investment activities are consistent with the predetermined expectations (i.e., stated policies and manager philosophy). Also, by running the report at various levels, unreasonably large concentrations of risk (that may jeopardize the portfolio) may be detected.

Liquidity Considerations

LO 69.8: Explain the importance of liquidity considerations for a portfolio.

Liquidity considerations are important because a portfolio's liquidity profile could change significantly in the midst of a volatile market environment or an economic downturn, for instance. Therefore, measuring portfolio liquidity is a priority in stress testing.

One potential measure is **liquidity duration**. It is an approximation of the number of days necessary to dispose of a portfolio's holdings without a significant market impact. For a given security, the liquidity duration could be calculated as follows:

$$LD = \frac{Q}{(0.10 \times V)}$$

where:
LD = liquidity duration for the security on the assumption that the desired maximum daily volume of any security is 10%
Q = number of shares of the security
V = daily volume of the security

Performance Measurement

LO 69.10: Describe the objectives of performance measurement.

Performance measurement looks at a portfolio manager's actual results and compares them to relevant comparables such as benchmarks and peer groups. Therefore, performance measurement seeks to determine whether a manager can consistently outperform (through excess returns) the benchmark on a risk-adjusted basis. Similarly, it seeks to determine whether a manager consistently outperforms its peer group on a risk-adjusted basis.

Furthermore, performance measurement may help to determine whether the returns achieved are commensurate with the risk taken. Finally, performance measurement provides a basis for identifying managers who are able to generate consistent excess risk-adjusted returns. Such superior processes and performance could be replicated on an on-going basis, thereby maximizing the entity's long-run returns and profitability.

Comparison of Performance with Expectations

From a risk perspective (e.g., tracking error), portfolio managers should be assessed on the basis of being able to produce a portfolio with risk characteristics that are expected to approximate the target. In addition, they should also be assessed on their ability to actually achieve risk levels that are close to target.

From a returns perspective (e.g., performance), portfolio managers could be assessed on their ability to earn excess returns.

Goldman Sachs Asset Management utilizes a so-called "green zone" to identify instances of actual tracking error or performance that are outside of normal expectations. An acceptable amount of deviation (from a statistical perspective) is determined, and any deviations up to that amount are considered a green zone event. Unusual events that are expected to occur with some regularity are considered "yellow zone" events. Truly unusual events that require immediate investigation are considered "red zone" events. In using this simple color-coded system, the various zones are predefined and provide clear expectations for the portfolio managers. The movements of portfolios into yellow or red zones are triggering events that require further investigation and discussion.

Return Attribution

The source of returns can be attributed to specific factors or securities. For example, it is important to ensure that returns result from decisions where the manager intended to take risk and not simply from sheer luck.

Variance analysis is used to illustrate the contribution to overall portfolio performance by each security. The securities can be regrouped in various ways to conduct analysis by industry, sector, and country, for example.

In performing return attribution, factor risk analysis and factor attribution could be used. Alternatively, risk forecasting and attribution at the security level could also be used.

Sharpe and Information Ratio

The **Sharpe ratio** is calculated by taking the portfolio's actual return and subtracting the risk-free rate in the numerator. The denominator is the portfolio's standard deviation. The **information ratio** is calculated by taking the portfolio's excess returns and subtracting the benchmark's excess returns (if applicable) in the numerator. The denominator is the portfolio's tracking error. These two measures are both considered risk-adjusted return measures.

Strengths of these metrics include the following: (1) easy to use as a measure of relative performance compared to a benchmark or peer group; (2) easy to determine if the manager has generated sufficient excess returns in relation to the amount of risk taken; and (3) easy to apply to industrial sectors and countries.

Weaknesses of these metrics include the following: (1) insufficient data available to perform calculations; and (2) the use of realized risk (instead of potential risk) may result in overstated performance calculations.

Comparisons with Benchmark Portfolios and Peer Groups

LO 69.9: Describe the use of alpha, benchmark, and peer group as inputs in performance measurement tools.

One could use linear regression analysis to regress the excess returns of the investment against the excess returns of the **benchmark**. One of the outputs from this regression is **alpha**, and it could be tested for statistical significance to determine whether the excess returns are attributable to manager skill or just pure luck. The other output is **beta**, and it relates to the amount of leverage used or underweighting/overweighting in the market compared to the benchmark.

The regression also allows a comparison of the absolute amount of excess returns compared to the benchmark. Furthermore, there is the ability to separate excess returns due to leverage and excess returns due to skill. One limitation to consider is that there may not be enough data available to make a reasonable conclusion as to the manager's skill.

One could also regress the excess returns of the manager against the excess returns of the manager's **peer group**. The features of this regression are generally similar to that for the benchmark, except that the returns of the peer group suffer from **survivorship bias**, and there is usually a wide range of funds under management amongst the peers (that reduces the comparability).

Key Concepts

LO 69.1

VaR and tracking error are both measures of risk. VaR is defined to be the largest loss possible for a certain level of confidence over a specific period of time. Tracking error is defined as the standard deviation of excess returns.

LO 69.2

There are five risk planning objectives to consider.

- Setting expected return and expected volatility goals.
- Defining quantitative measures of success or failure.
- Generalizing how risk capital will be utilized to meet the entity's objectives.
- Defining the difference between events that cause ordinary damage versus serious damage.
- Identifying mission critical resources inside and outside the entity and discussing what should be done in case those resources are jeopardized.

The risk planning process frequently requires the input and approval of the entity's owners and its management team.

LO 69.3

The risk budget quantifies the risk plan. There needs to be a structured budgeting process to allocate risk capital to meet the corporate objectives and minimize deviations from plan.

Quantitative methods may be used in risk budgeting. Activities include: setting the minimum acceptable levels of RORC and ROE, applying mean-variance optimization, simulating portfolio performance, and applying sensitivity analysis.

LO 69.4

Within an entity's internal control environment, risk monitoring attempts to seek and investigate any significant variances from budget.

LO 69.5

Sources of risk consciousness include: (1) banks, (2) boards of investment clients, senior management, and plan sponsors, and (3) investors.

LO 69.6

A risk management unit (RMU) monitors an investment management entity's portfolio risk exposure and ascertains that the exposures are authorized and consistent with the risk budgets previously set. To ensure proper segregation of duties, it is crucial that the risk management function be independent and not report to senior management.

LO 69.7

The risk monitoring process attempts to confirm that investment activities are consistent with expectations. Specifically, is the manager generating a forecasted level of tracking error that is consistent with the target? And is risk capital allocated to the expected areas?

LO 69.8

Liquidity considerations are important because a portfolio's liquidity profile could change significantly in the midst of a volatile market environment or an economic downturn, for instance.

LO 69.9

The excess returns of an investment can be regressed against the excess returns of its benchmark (e.g., S&P 500 Index). An output from this regression is alpha, which determines whether the investment's excess returns are due to skill or luck.

The excess returns of a manager can be regressed against the excess returns of the manager's peer group. This is similar to the liner regression with a benchmark portfolio, but differs since it suffers from survivorship bias.

LO 69.10

Performance measurement looks at a portfolio manager's actual results and compares them to relevant comparables such as benchmarks and peer groups.

A performance measurement framework includes: (1) comparison of performance with expectations, (2) return attribution, (3) calculation of metrics such as the Sharpe ratio and the information ratio, and (4) comparisons with benchmark portfolios and peer groups.

Concept Checkers

1. Which of the following statements about tracking error and value at risk (VaR) is least accurate?
   A. Tracking error and VaR are complementary measures of risk.
   B. Both tracking error and VaR may assume a normal distribution of returns.
   C. Tracking error is the standard deviation of the excess of portfolio returns over the return of the peer group.
   D. VaR can be defined as the maximum loss over a given time period.

2. Which of the following statements about the use of quantitative methods in risk budgeting is least accurate? They may be used:
   A. to simulate the performance of portfolios.
   B. to set levels of return on equity (ROE) and return on risk capital (RORC).
   C. in a scenario analysis context to determine the weights for each asset class.
   D. in a sensitivity analysis context to consider changes in estimates of returns and covariances.

3. A risk management unit (RMU) is most likely to be active in which of the following contexts?
   A. Risk monitoring.
   B. Risk measurement.
   C. Risk budgeting.
   D. Risk planning.

4. Which of the following statements does not help explain the purpose of risk decomposition?
   A. To ensure that there is no style drift.
   B. To detect large concentrations of risk.
   C. To detect excessive amounts of tracking risk.
   D. To ensure that investment activities are consistent with expectations.

5. Which of the following statements regarding alphas and betas is incorrect?
   A. Alpha is the excess return attributable to pure luck.
   B. Alpha is the excess return attributable to managerial skill.
   C. Beta suggests the relative amount of leverage used.
   D. Beta suggests whether some of the returns are attributable to over or under weighting the market.

Concept Checker Answers

1. C All of the statements are accurate with the exception of the one relating to the peer group. Tracking error is the standard deviation of the excess of portfolio returns over the return of an appropriate benchmark, not peer group.

2. C All of the statements are accurate with the exception of the one relating to scenario analysis. One should apply mean-variance optimization (and not scenario analysis) to determine the weights for each asset class.

3. A A RMU monitors an investment management firm's portfolio risk exposure and ascertains that the exposures are authorized and consistent with the risk budgets previously set.

4. C Risk decomposition is not designed to detect excessive amounts of tracking risk. In fact, it is the forecasted tracking error amount that should be compared to budget to ensure that there is not excessive tracking risk. All the other reasons are consistent with the purpose of risk decomposition.

5. A Alpha is a measure of the excess return of a manager over the peer group/benchmark that relates to skill as opposed to pure luck. Beta is a measure of the amount of leverage used compared to the peer group or a measure of the underweighting or overweighting of the market compared to the benchmark.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Portfolio Performance Evaluation

Topic 70

Exam Focus

Professional money managers are routinely evaluated using a wide array of metrics. In this topic, alternative methods of computing portfolio returns will be presented, and contrasts will be made between time-weighted and dollar-weighted returns for portfolios experiencing cash redemptions and contributions. For the exam, be sure to understand differences in the risk-adjusted performance measures, including the Sharpe ratio, Treynor ratio, Jensen's alpha, information ratio, and M^2, and how the trading practices of hedge funds complicates the evaluation process. Be able to apply Sharpe's regression-based style analysis to conduct performance attributions.

Time-Weighted and Dollar-Weighted Returns

LO 70.1: Differentiate between time-weighted and dollar-weighted returns of a portfolio and describe their appropriate uses.

The **dollar-weighted rate of return** is defined as the internal rate of return (IRR) on a portfolio, taking into account all cash inflows and outflows. The beginning value of the account is an inflow as are all deposits into the account. All withdrawals from the account are outflows, as is the ending value.

Example: Dollar-weighted rate of return

Assume an investor buys a share of stock for $100 at t = 0, and at the end of the next year (t = 1), she buys an additional share for $120. At the end of year 2, the investor sells both shares for $130 each. At the end of each year in the holding period, the stock paid a $2.00 per share dividend. What is the investor's dollar-weighted rate of return?

Answer:

Step 1: Determine the timing of each cash flow and whether the cash flow is an inflow (+) or an outflow (–).

t = 0:	purchase of first share	=	–$100
t = 1:	dividend from first share	=	+$2
	purchase of second share	=	–$120
	subtotal, t = 1		–$118
t = 2:	dividend from two shares	=	+$4
	proceeds from selling shares	=	+$260
	subtotal, t = 2		+$264

Step 2: Net the cash flows for each time period, and set the PV of cash inflows equal to the present value of cash outflows.

$$PV_{inflows} = PV_{outflows}$$

$$\$100 + \frac{\$120}{(1+r)} = \frac{\$2}{(1+r)} + \frac{\$264}{(1+r)^2}$$

Step 3: Solve for *r* to find the dollar-weighted rate of return. This can be done using trial and error or by using the IRR function on a financial calculator or spreadsheet.

The intuition here is that we deposited $100 into the account at t = 0, then added $118 to the account at t = 1 (which, with the $2 dividend, funded the purchase of one more share at $120), and ended with a total value of $264.

To compute this value with a financial calculator, use these net cash flows and follow the procedure described in Figure 1 to calculate the IRR.

Net cash flows: $CF_0 = -100$; $CF_1 = -120 + 2 = -118$; $CF_2 = 260 + 4 = 264$

Figure 1: Calculating Dollar-Weighted Return With the TI Business Analyst II Plus® Calculator

Key Strokes	*Explanation*	*Display*
[CF] [2nd] [CLR WORK]	Clear cash flow registers	CF0 = 0.00000
100 [+/–] [ENTER]	Initial cash outlay	CF0 = –100.00000
[↓] 118 [+/–] [ENTER]	Period 1 cash flow	C01 = –118.00000
[↓] [↓] 264 [ENTER]	Period 2 cash flow	C02 = 264.00000
[IRR] [CPT]	Calculate IRR	IRR = 13.86122

The dollar-weighted rate of return for this problem is 13.86%.

Time-weighted rate of return measures compound growth. It is the rate at which $1.00 compounds over a specified time horizon. Time-weighting is the process of averaging a set of values over time. The *annual* time-weighted return for an investment may be computed by performing the following steps:

Step 1: Value the portfolio immediately preceding significant addition or withdrawals. Form subperiods over the evaluation period that correspond to the dates of deposits and withdrawals.

Step 2: Compute the holding period return (HPR) of the portfolio for each subperiod.

Step 3: Compute the product of $(1 + HPR_t)$ for each subperiod t to obtain a total return for the entire measurement period [i.e., $(1 + HPR_1) \times (1 + HPR_2) \ldots (1 + HPR_n)$]. If the total investment period is greater than one year, you must take the geometric mean of the measurement period return to find the annual time-weighted rate of return.

Example: Time-weighted rate of return

A share of stock is purchased at t = 0 for $100. At the end of the next year, t = 1, another share is purchased for $120. At the end of year 2, both shares are sold for $130 each. At the end of years 1 and 2, the stock paid a $2.00 per share dividend. What is the time-weighted rate of return for this investment? (This is the same data as presented in the dollar-weighted rate-of-return example.)

Answer:

Step 1: Break the evaluation period into two subperiods based on timing of cash flows.

Holding period 1:
beginning price = $100.00
dividends paid = $2.00
ending price = $120.00

Holding period 2:
beginning price = $240.00 (2 shares)
dividends paid = $4.00 ($2 per share)
ending price = $260.00 (2 shares)

Step 2: Calculate the HPR for each holding period.

$HPR_1 = [(\$120 + 2) / \$100] - 1 = 22\%$

$HPR_2 = [(\$260 + 4) / \$240] - 1 = 10\%$

Step 3: Take the geometric mean of the annual returns to find the annualized time-weighted rate of return over the measurement period.

$$(1 + \text{time-weighted rate of return})^2 = (1.22)(1.10)$$

$$\text{time-weighted rate of return} = \left[\sqrt{(1.22)(1.10)}\right] - 1 = 15.84\%$$

In the investment management industry, the time-weighted rate of return is the preferred method of performance measurement for a portfolio manager because it is not affected by the timing of cash inflows and outflows, which may be beyond the manager's control.

In the preceding examples, the time-weighted rate of return for the portfolio was 15.84%, while the dollar-weighted rate of return for the same portfolio was 13.86%. The difference in the results is attributable to the fact that the procedure for determining the dollar-weighted rate of return gave a larger weight to the year 2 HPR, which was 10% versus the 22% HPR for year 1.

If funds are contributed to an investment portfolio just before a period of relatively poor portfolio performance, the dollar-weighted rate of return will tend to be depressed. Conversely, if funds are contributed to a portfolio at a favorable time, the dollar-weighted rate of return will increase. The use of the time-weighted return removes these distortions, providing a better measure of a manager's ability to select investments over the period. If a private investor has complete control over money flows into and out of an account, the dollar-weighted rate of return may be the more appropriate performance measure.

Therefore, the dollar-weighted return will exceed the time-weighted return for a manager who has superior market timing ability.

Risk-Adjusted Performance Measures

LO 70.2: Describe and distinguish between risk-adjusted performance measures, such as Sharpe's measure, Treynor's measure, Jensen's measure (Jensen's alpha), and information ratio.

LO 70.3: Describe the uses for the Modigliani-squared and Treynor's measure in comparing two portfolios, and the graphical representation of these measures.

Universe Comparisons

Portfolio rankings based merely on returns ignore differences in risk across portfolios. A popular alternative is to use a comparison universe. This approach classifies portfolios according to investment style (e.g., small cap growth, small cap value, large cap growth, large cap value) and, then, ranks portfolios based on rate of return within the appropriate style universe. The rankings are now more meaningful because they have been standardized on the investment style of the funds. This method will fail, however, if risk differences remain across the funds within a given style.

The Sharpe Ratio

The **Sharpe ratio** uses standard deviation (total risk) as the relevant measure of risk. It shows the amount of excess return (over the risk-free rate) earned per unit of total risk. Hence, the Sharpe ratio evaluates the performance of the portfolio in terms of both overall return and diversification.

The Sharpe ratio is defined as:

$$S_A = \frac{\overline{R}_A - \overline{R}_F}{\sigma_A}$$

where:
$\overline{R}_A$ = average account return
$\overline{R}_F$ = average risk-free return
σ_A = standard deviation of account returns

Professor's Note: Again, the risk measure, standard deviation, should ideally be the actual standard deviation during the measurement period.

The Treynor Measure

The **Treynor measure** is very similar to the Sharpe ratio except that it uses beta (systematic risk) as the measure of risk. It shows the excess return (over the risk-free rate) earned per unit of systematic risk.

The Treynor measure is defined as:

$$T_A = \frac{\overline{R}_A - \overline{R}_F}{\beta_A}$$

where:
$\overline{R}_A$ = average account return
$\overline{R}_F$ = average risk-free return
β_A = average beta

Professor's Note: Ideally, the Treynor measure should be calculated using the actual beta for the portfolio over the measurement period. Since beta is subject to change due to varying covariance with the market, using the premeasurement period beta may not yield reliable results. The beta for the measurement period is estimated by regressing the portfolio's returns against the market returns.

For a well-diversified portfolio, the difference in risk measurement between the Sharpe ratio and the Treynor measure becomes irrelevant as the total risk and systematic risk will be very close. For a less than well-diversified portfolio, however, the difference in rankings based on the two measures is likely due to the amount of diversification in the portfolio. Used along with the Treynor measure, the Sharpe ratio provides additional information about the degree of diversification in a portfolio.

Sharpe vs. Treynor. If a portfolio was not well-diversified over the measurement period, it may be ranked relatively higher using Treynor than using Sharpe because Treynor considers only the beta (i.e., systematic risk) of the portfolio over the period. When the Sharpe ratio is calculated for the portfolio, the excess total risk (standard deviation) due to diversifiable risk will cause rankings to be lower. Although we do not get an absolute measure of the lack of

diversification, the change in the rankings shows the presence of unsystematic risk, and the greater the difference in rankings, the less diversified the portfolio.

Jensen's Alpha

Jensen's alpha, also known as Jensen's measure, is the difference between the actual return and the return required to compensate for systematic risk. To calculate the measure, we subtract the return calculated by the capital asset pricing model (CAPM) from the account return. Jensen's alpha is a direct measure of performance (i.e., it yields the performance measure without being compared to other portfolios).

$$\alpha_A = R_A - E(R_A)$$

where:
α_A = alpha
R_A = the return on the account
$E(R_A) = R_F + \beta_A[E(R_M) - R_F]$

A superior manager would have a statistically significant and positive alpha. Jensen's alpha uses the portfolio return, market return, and risk-free rate for each time period separately. The Sharpe and Treynor measures use only the average of portfolio return and risk-free rate. Furthermore, like the Treynor measure, Jensen's alpha only takes into account the systematic risk of the portfolio and, hence, gives no indication of the diversification in the portfolio.

Information Ratio

The Sharpe ratio can be changed to incorporate an appropriate benchmark instead of the risk-free rate. This form is known as the **information ratio** or **appraisal ratio**:

$$IR_A = \frac{\bar{R}_A - \bar{R}_B}{\sigma_{A-B}}$$

where:
$\bar{R}_A$ = average account return
$\bar{R}_B$ = average benchmark return
σ_{A-B} = standard deviation of excess returns measured as the difference between account and benchmark returns

The information ratio is the ratio of the surplus return (in a particular period) to its standard deviation. It indicates the amount of risk undertaken (denominator) to achieve a certain level of return above the benchmark (numerator). An active manager makes specific cognitive bets to achieve a positive surplus return. The variability in the surplus return is a measure of the risk taken to achieve the surplus. The ratio computes the surplus return relative to the risk taken. A higher information ratio indicates better performance.

Professor's Note: The version of the information ratio presented here is the most common. However, you should be aware that an alternative calculation of this ratio exists that uses alpha over the expected level of unsystematic risk over the time period, $\frac{\alpha_A}{\sigma(\varepsilon_A)}$.

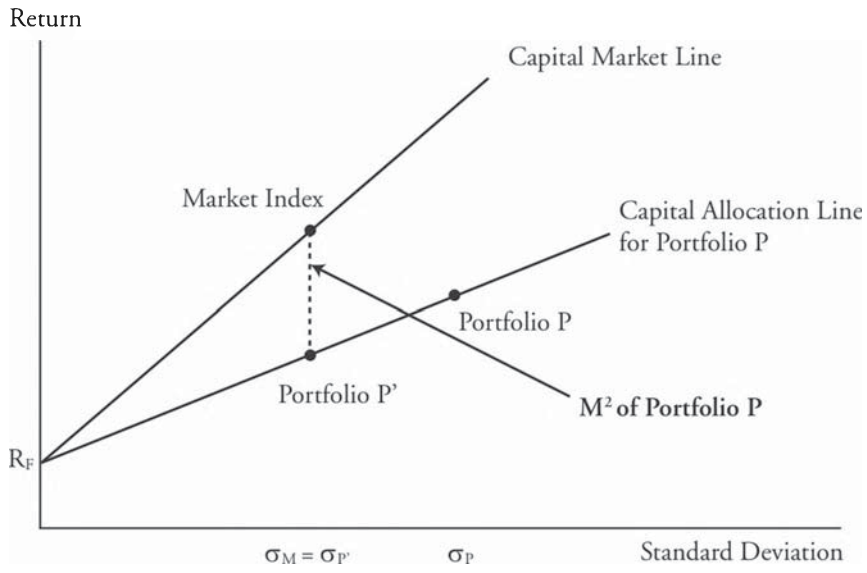
M-Squared (M^2) Measure

A relatively new measure of portfolio performance developed by Leah Modigliani and her grandfather, 1985 Nobel Prize recipient Franco Modigliani, has become quite popular. The M^2 measure compares the return earned on the managed portfolio against the market return, after adjusting for differences in standard deviations between the two portfolios.

Professor's Note: There are no squared terms in the M-squared calculation. The term "M-squared" merely refers to the last names of its originators (Leah and Franco Modigliani).

The M^2 measure can be illustrated with a graph comparing the capital market line for the market index and the capital allocation line for managed Portfolio P. In Figure 2, notice that Portfolio P has a higher standard deviation than the market index. But, we can easily create a Portfolio P' that has standard deviation equal to the market standard deviation by investing appropriate percentages in both the risk-free asset and Portfolio P. The difference in return between Portfolio P' and the market portfolio, equals the M^2 measure for Portfolio P.

Figure 2: The M^2 Measure of Portfolio Performance



Example: Calculating the M^2 performance measure

Calculate the M^2 measure for Portfolio P:

- Portfolio P mean return 10%
- Portfolio P standard deviation 40%
- Market portfolio mean return 12%
- Market portfolio standard deviation 20%
- Risk-free rate 4%

Answer:

To answer the question, first note that a portfolio, P', can be created that allocates 50/50 to the risk-free asset and to Portfolio P such that the standard deviation of Portfolio P' equals the standard deviation of the market portfolio:

$$\sigma_{P'} = w_P\sigma_P = 0.50(0.40) = 0.20$$

Therefore, a 50/50 allocation between Portfolio P and the risk-free asset provides risk identical to the market portfolio. What is the difference in return between Portfolio P' and the market portfolio? To answer this question, first we must derive the mean return on Portfolio P':

$$R_{P'} = w_F R_F + w_P R_P = 0.50(0.04) + 0.50(0.10) = 0.07$$

Alternatively, the mean return for Portfolio P' can be derived by using the equation of the capital allocation line for Portfolio P:

$$R_{P'} = R_F + \left(\frac{R_P - R_F}{\sigma_P}\right)\sigma_{P'} = R_F + \left(\frac{R_P - R_F}{\sigma_P}\right)\sigma_M$$

$$= 0.04 + \left(\frac{0.10 - 0.04}{0.40}\right)0.20 = 0.04 + (0.15)0.20 = 0.07$$

Therefore, we now have created a portfolio, P', that matches the risk of the market portfolio (standard deviation equals 20%). All that remains is to calculate the difference in returns between Portfolio P' and the market portfolio:

$$M^2 = R_{P'} - R_M = 0.07 - 0.12 = -0.05$$

Clearly, Portfolio P is a poorly performing portfolio. After controlling for risk, Portfolio P provides a return that is 5 percentage points below the market portfolio.

Professor's Note: Unfortunately, a consistent definition of M^2 does not exist. Sometimes M^2 is defined as equal to the return on the risk-adjusted Portfolio P' rather than equal to the difference in returns between P' and M. However, portfolio rankings based on the return on P' or on the difference in returns between P' and M will be identical. Therefore, both definitions provide identical portfolio performance rankings.

M^2 will produce the same conclusions as the Sharpe ratio. As stated earlier, Jensen's alpha will produce the same conclusions as the Treynor measure. However, M^2 and Sharpe may not give the same conclusion as Jensen's alpha and Treynor. A discrepancy could occur if the manager takes on a large proportion of unsystematic risk relative to systematic risk. This would lower the Sharpe ratio but leave the Treynor measure unaffected.

Example: Risk-adjusted performance appraisal measures

The data in Figure 3 has been collected to appraise the performance of four asset management firms:

Figure 3: Performance Appraisal Data

	Fund 1	*Fund 2*	*Fund 3*	*Fund 4*	*Market Index*
Return	6.45%	8.96%	9.44%	5.82%	6%
Beta	0.88	1.02	1.36	0.80	1.00
Standard deviation	2.74%	4.54%	3.72%	2.64%	2.80%
Standard deviation of excess returns	5.6%	6.1%	12.5%	5.3%	N/A

The market index return and risk-free rate of return for the relevant period were 6% and 3%, respectively. **Calculate** and **rank** the funds using Jensen's alpha, the Treynor measure, the Sharpe ratio, the information ratio, and M^2.

Answer:

Evaluation Tool	*Fund 1*	*Fund 2*	*Fund 3*	*Fund 4*
Jensen's Alpha	6.45 – 5.64 = 0.81%	8.96 – 6.06 = 2.90%	9.44 – 7.08 = 2.36%	5.82 – 5.40 = 0.42%
Rank	3	1	2	4
Treynor	$\frac{6.45-3}{0.88}=3.92$	$\frac{8.96-3}{1.02}=5.84$	$\frac{9.44-3}{1.36}=4.74$	$\frac{5.82-3}{0.80}=3.53$
Rank	3	1	2	4
Sharpe	$\frac{6.45-3}{2.74}=1.26$	$\frac{8.96-3}{4.54}=1.31$	$\frac{9.44-3}{3.72}=1.73$	$\frac{5.82-3}{2.64}=1.07$
Rank	3	2	1	4
Information Ratio	$\frac{6.45-6}{5.6}=0.08$	$\frac{8.96-6}{6.1}=0.49$	$\frac{9.44-6}{12.5}=0.28$	$\frac{5.82-6}{5.3}=-0.03$
Rank	3	1	2	4
M^2	3 + (1.26) × (2.8) = 6.53% – 6% =0.53%	3 + (1.31) × (2.8) = 6.67% – 6% =0.67%	3 + (1.73) × (2.8) = 7.84% – 6% 1.84%	3 + (1.07) × (2.8) = 6% – 6% =0
Rank	3	2	1	4

Note that Jensen's alpha and the Treynor measures give the same rankings, and the Sharpe and M^2 measures give the same rankings. However, when comparing the alpha/Treynor rankings to the Sharpe/M^2 measures, Funds 2 and 3 trade places.

Fund 2 has a much higher total risk (standard deviation) than Fund 3 but has a much lower beta. Relatively speaking, a smaller proportion of Fund 2's total risk relates to systematic risk, which is reflected in the low beta. Compared to Fund 3, it must have a bigger proportion of risk relating to non-systematic risk factors.

Hence, Fund 2 does better in the alpha/Treynor measures, as those measures only look at systematic risk (beta). It fares less well when it comes to the Sharpe/M^2 measures that look at total risk.

Statistical Significance of Alpha Returns

LO 70.4: Determine the statistical significance of a performance measure using standard error and the t-statistic.

Alpha (α) plays a critical role in determining portfolio performance. A positive alpha produces an indication of superior performance; a negative alpha produces an indication of inferior performance; and zero alpha produces an indication of normal performance matching the benchmark. The performance indicated by alpha, however, could be a result of luck and not skill. In order to assess a manager's ability to generate alpha, we conduct a *t*-test under the following hypotheses:

Null (H_0): True alpha is zero.

Alternative (H_A): True alpha is not zero.

$$t = \frac{\alpha - 0}{\sigma / \sqrt{N}}$$

where:
α = alpha estimate
σ = alpha estimate volatility
N = sample number of observations
standard error of alpha estimate = $\sigma / \sqrt{N}$

In order to compute the ***t*-statistic**, we will need to know the alpha estimate, the sample number of observations, and the alpha estimate of volatility. From the volatility and sample size estimates, we can compute the **standard error** of the alpha estimate, which is shown in the denominator of the *t*-statistic calculation.

At a 95% confidence level (5% significance level) we reject the null hypothesis if we estimate a *t*-value of 2 or larger. That is, the probability of observing such a large estimated alpha by chance is only 5%, assuming returns are normally distributed.

Professor's Note: Using a t-value of 2 is a general test of statistical significance. From the FRM Part I curriculum, we know that the actual t-value with a 95% confidence level given a large sample size is 1.96.

If we assume an excess (alpha) return of 0.09% and a standard error of the alpha of 0.093%, the *t*-statistic would be equal to 0.97 (t = 0.09% / 0.093%); therefore, we fail to reject H_0 and conclude that there is no evidence of superior (or inferior) performance.

Professor's Note: Using statistical inference when evaluating performance is extremely challenging in practice. By the time you are reasonably confident that a manager's returns are in fact due to skill, the manager may have moved elsewhere.

Measuring Hedge Fund Performance

LO 70.5: Explain the difficulties in measuring the performance of hedge funds.

Long-short hedge funds are often used to complement an investor's well-diversified portfolio. For example, the investor might allocate funds to a passively managed index fund and an actively managed long-short hedge fund. The hedge fund is designed to provide positive alpha with zero beta to the investor's overall composite portfolio. The hedge fund creates **portable alpha** in the sense that the alpha does not depend on the performance of the broad market and can be ported to any existing portfolio. Because the long-short fund is market-neutral, the alpha may be generated outside the investor's desired asset class mix.

Unfortunately, hedge fund performance evaluation is complicated because:

- Hedge fund risk is not constant over time (nonlinear risk).
- Hedge fund holdings are often illiquid (data smoothing).
- Hedge fund sensitivity with traditional markets increases in times of a market crisis and decreases in times of market strength.

The latter problem necessitates the use of estimated prices for hedge fund holdings. The values of the hedge funds, therefore, are not transactions-based. The estimation process unduly smoothes the hedge fund "values," inducing serial correlation into any statistical examination of the data.

Performance Evaluation With Dynamic Risk Levels

LO 70.6: Explain how changes in portfolio risk levels can affect the use of the Sharpe ratio to measure performance.

The Sharpe ratio is useful when evaluating the portfolio performance of a passive investment strategy, where risk and return characteristics are relatively constant over time. However, the application of the Sharpe ratio is challenged when assessing the performance of active investment strategies, where risk and return characteristics are more dynamic. Changes in volatility will likely bias the Sharpe ratio, and produce incorrect conclusions when comparing portfolio performance to a benchmark or index.

Take for example a low-risk portfolio with an alpha return of 1% and a standard deviation of 3%. The manager implements this strategy for one-year, producing quarterly returns of –2%, 4%, –2%, and 4%. The Sharpe ratio for this portfolio is calculated as:
1% / 3% = 0.3333. If the market index has a Sharpe ratio of 0.3, we would conclude that this portfolio has superior risk-adjusted performance. In the following year, the portfolio manager decides to switch to a high-risk strategy. The alpha return and risk correspondingly increase to 5% and 15%, respectively. For the second year, quarterly returns were –10%, 20%, –10%, and 20%. The Sharpe ratio in this case is still 0.3333 (= 5% / 15%), which still indicates superior performance compared to the market index. However, if the Sharpe ratio is evaluated over the two-year time frame, considering both the low-risk and high-risk strategies, the measure will drop to 0.2727 since average excess return over both years was 3% with volatility of 11%. The lower Sharpe ratio now suggests underperformance relative to the market index.

In this example, the Sharpe ratio was biased downward due to the perceived increase in risk in portfolio returns. In isolation, both the low-risk and high-risk strategies produced higher Sharpe ratios than the market index. However, when analyzed together, the Sharpe ratio suggests that the portfolio excess returns are inferior to the market. Therefore, it is important to consider changes in portfolio composition when using performance measures, as dynamic risk levels can lead to incorrect ranking conclusions.

Measuring Market Timing Ability

LO 70.7: Describe techniques to measure the market timing ability of fund managers with a regression and with a call option model, and compute return due to market timing.

Measuring Market Timing with Regression

Extending basic return regression models offers a tool to assess superior market timing skills of a portfolio manager. A market timer will include high (low) beta stocks in her portfolio if she expects an up (down) market. If her forecasts are accurate, her portfolio will outperform the benchmark portfolio. Using a market timing regression model, we can empirically test whether there is evidence of superior market timing skills exhibited by the portfolio manager. The regression equation used for this test is as follows:

$$R_P - R_F = \alpha + \beta_P(R_M - R_F) + M_P(R_M - R_F)D + \varepsilon_P$$

In this equation, *D* is a dummy variable that is assigned a value of 0 for down markets (i.e., when $R_M < R_F$) and 1 for up markets (i.e., when $R_M > R_F$). M_P is the difference between the up market and down market betas and will be positive for a successful market timer. In a bear market, beta is simply equal to β_P. In a bull market, beta is equal to $\beta_P + M_P$. Empirical evidence of mutual fund return data suggests that M_P is actual negative for most funds. Thus, researchers have concluded that fund managers exhibit little, if any, ability to correctly time the market.

Measuring Market Timing with a Call Option Model

Consider an investor who has 100% perfect market forecasting ability and holds a portfolio allocated either 100% to Treasury bills or 100% to the S&P 500 equity market index, depending on the forecast performance of the S&P 500 versus the Treasury bill return. The investor's portfolio will be:

100% invested in the S&P 500 if $E(R_M) > R_F$
100% invested in Treasury bills if $E(R_M) < R_F$

If the investor has perfect forecasting ability, then his return performance will be as follows:

R_M if $R_M > R_F$
R_F if $R_M < R_F$

Now consider an investor who invests S_0 (the current value of the S&P 500) in Treasury bills and also owns a call option on the S&P 500 with exercise price equal to the current value of the index times $(1 + R_F)$, or $S_0(1+R_F)$. Note that the exercise price equals the value of the S&P 500 if it grows at a rate equal to the risk-free rate.

What are the return possibilities for this investor? To answer this question, note that if the S&P 500 holding period return exceeds the risk-free rate, then the ending value of the call option will be:

$$S_T - X = S_0(1+R_M) - S_0(1+R_F)$$

The investor also owns Treasury bills with face value equal to $S_0(1+R_F)$. Therefore, the face value (FV) of the Treasury bills will perfectly offset the exercise price of the call option. In the up-market scenario, the ending value of the calls plus bills portfolio equals:

$$S_T - X + FV = S_0(1+R_M) - S_0(1+R_F) + S_0(1+R_F) = S_0(1+R_M)$$

Therefore, the return performance on the calls plus bills portfolio will equal:

R_M if $R_M > R_F$

If the market rises by less than the risk-free rate, the call option has no value, but the risk-free asset will still return R_F. Therefore, the down-market scenario return for the calls plus bills portfolio is:

R_F if $R_M < R_F$

In summary, the returns to the calls plus bills portfolio are identical to the 100% perfect foresight returns. Therefore, the value or appropriate fee for perfect foresight should equal the price of the call option on the market index.

Style Analysis

LO 70.8: Describe style analysis.

LO 70.9: Describe and apply performance attribution procedures, including the asset allocation decision, sector and security selection decision, and the aggregate contribution.

William Sharpe introduced the concept of style analysis. From January 1985 to December 1989 he analyzed the returns on Fidelity's Magellan Fund for style and selection bets. His study concluded that 97.3% of the fund's returns were explained by style bets (asset allocation), and 2.7% were due to selection bets (individual security selection and market timing). The importance of long-run asset allocation has been well established empirically. These results suggest that the returns to market timing and security selection are minimal at best and at worst insufficient to cover the associated operating expenses and trading costs.

The steps for Sharpe's style analysis are as follows:

1. Run a regression of portfolio returns against an exhaustive and mutually exclusive set of asset class indices:

   $$R_P = b_{P1}R_{B1} + b_{P2}R_{B2} + ...+ b_{Pn}R_{Bn} + e_P$$

   where:
   R_P = return on the managed portfolio
   R_{Bj} = return on passive benchmark asset class n
   b_{Pj} = sensitivity or exposure of Portfolio P return to passive asset class n return
   e_P = random error term

In Sharpe's style analysis, the slopes are constrained to be non-negative and to sum to 100%. In that manner, the slopes can be interpreted to be "effective" allocations of the portfolio across the asset classes.

2. Conduct a performance attribution (return attributable to asset allocation and to selection):
   - The percent of the performance attributable to asset allocation = R^2 (the coefficient of determination).
   - The percent of the performance attributable to selection = $1 - R^2$.

The **asset allocation attribution** equals the difference in returns attributable to active asset allocation decisions of the portfolio manager:

$$[b_1R_{B1} + b_2R_{B2} + ...+ b_nR_{Bn}] - R_B$$

Notice if the slopes (estimated allocations) for the managed portfolio equal those within the benchmark (passive asset allocation), then the asset allocation attribution will be zero.

The **selection attribution** equals the difference in returns attributable to superior individual security selection (correct selection of mispriced securities) and sector allocation (correct over and underweighting of sectors within asset classes):

$$R_P - [b_1R_{B1} + b_2R_{B2} + ...+ b_nR_{Bn}]$$

Notice if the manager has no superior selection ability, then portfolio returns earned within each asset class will equal the benchmark asset class returns: $R_{Pj} = R_{Bj}$, and the selection attribution will equal zero. Also, notice that the sum of the two attribution components (asset allocation plus selection) equals the total excess return performance: $R_P - R_B$.

3. Uncover the investment style of the portfolio manager: the regression slopes are used to infer the investment style of the manager. For example, assume the following results are derived:

   $$R_P = 0.75R_{LCG} + 0.15R_{LCV} + 0.05R_{SCG} + 0.05R_{SCV}$$

   where:
   R_{LCG} = return on the large cap growth index
   R_{LCV} = return on the large cap value index
   R_{SCG} = return on the small cap growth index
   R_{SCV} = return on the small cap value index

The regression results indicate that the manager is pursuing primarily a large cap growth investment style.

Key Concepts

LO 70.1

The dollar-weighted rate of return is defined as the internal rate of return (IRR) on a portfolio, taking into account all cash inflows and outflows. The beginning value of the account is an inflow as are all deposits into the account. All withdrawals from the account are outflows, as is the ending value.

Time-weighted rate of return measures compound growth. It is the rate at which $1 compounds over a specified time horizon. Time-weighting is the process of averaging a set of values over time.

LO 70.2

The Sharpe ratio uses standard deviation (total risk) as the relevant measure of risk. It shows the amount of excess return (over the risk-free rate) earned per unit of total risk.

The Treynor measure is very similar to the Sharpe ratio except that it uses beta (systematic risk) as the measure of risk. It shows the excess return (over the risk-free rate) earned per unit of systematic risk.

Jensen's alpha is the difference between the actual return and the return required to compensate for systematic risk. To calculate the measure, we subtract the return calculated by the capital asset pricing model (CAPM) from the account return.

The information ratio is the ratio of the surplus return (in a particular period) to its standard deviation. It indicates the amount of risk undertaken to achieve a certain level of return above the benchmark.

LO 70.3

The M^2 measure compares the return earned on the managed portfolio against the market return, after adjusting for differences in standard deviations between the two portfolios.

LO 70.4

A positive alpha produces an indication of superior performance; a negative alpha produces an indication of inferior performance; and zero alpha produces an indication of normal performance matching the benchmark.

LO 70.5

Hedge fund performance evaluation is complicated because:

- Hedge fund risk is not constant over time (nonlinear risk).
- Hedge fund holdings are often illiquid (data smoothing).
- Hedge fund sensitivity with traditional markets increases in times of a market crisis and decreases in times of market strength.

LO 70.6

Changes in volatility will likely bias the Sharpe ratio, and produce incorrect conclusions when comparing portfolio performance to a benchmark or index.

LO 70.7

Extending basic return regression models offers a tool to assess superior market timing skills of a portfolio manager. A market timer will include high (low) beta stocks in her portfolio if she expects an up (down) market. If her forecasts are accurate, her portfolio will outperform the benchmark portfolio.

LO 70.8

William Sharpe introduced the concept of style analysis. From January 1985 to December 1989 he analyzed the returns on Fidelity's Magellan Fund for style and selection bets. His study concluded that 97.3% of the fund's returns were explained by style bets (asset allocation), and 2.7% were due to selection bets (individual security selection and market timing).

LO 70.9

The importance of long-run asset allocation has been well established empirically. Historical results suggest that the returns to market timing and security selection are minimal at best and at worst insufficient to cover the associated operating expenses and trading costs.

Concept Checkers

Use the following data to answer Questions 1 and 2.

Assume you purchase a share of stock for $50 at time t = 0 and another share at $65 at time t = 1, and at the end of year 1 and year 2, the stock paid a $2.00 dividend. Also at the end of year 2, you sold both shares for $70 each.

1. The dollar-weighted rate of return on the investment is:
   A. 10.77%.
   B. 15.45%.
   C. 15.79%.
   D. 18.02%.

2. The time-weighted rate of return on the investment is:
   A. 18.04%.
   B. 18.27%.
   C. 20.13%.
   D. 21.83%.

3. The following information is available for funds ABC, RST, JKL, and XYZ:

Fund	*Annual Rate of Return*	*Beta*	*Volatility*
ABC	15%	1.25	20%
RST	18%	1.00	25%
JKL	25%	1.20	15%
XYZ	11%	1.36	9%

The average risk-free rate was 5%. Rank the funds from best to worst according to their Treynor measure.
A. JKL, RST, ABC, XYZ.
B. JKL, RST, XYZ, ABC.
C. RST, JKL, ABC, XYZ.
D. XYZ, ABC, RST, JKL.

Use the following information to answer Question 4.

The following data has been collected to appraise funds A, B, C, and D:

	Fund A	*Fund B*	*Fund C*	*Fund D*	*Market Index*
Return	8.25%	7.21%	9.44%	10.12%	8.60%
Beta	0.91	0.84	1.02	1.34	1.00
Standard deviation	3.24%	3.88%	3.66%	3.28%	3.55%

The risk-free rate of return for the relevant period was 4%.

4. Calculate and rank the funds from best to worst using Jensen's alpha.
   A. B, D, A, C.
   B. A, C, D, B.
   C. C, A, D, B.
   D. C, D, A, B.

5. Sharpe's style analysis, used to evaluate an active portfolio manager's performance, measures performance relative to:
   A. a passive benchmark of the same style.
   B. broad-based market indices.
   C. the performance of an equity index fund.
   D. an average of similar actively managed investment funds.

Concept Checker Answers

1. **D** One way to do this problem is to set up the cash flows so that the PV of inflows = PV of outflows and then to plug in each of the multiple choices.

   50 + 65 / (1 + IRR) = 2 / (1 + IRR) + 144 / (1 + IRR)^2 → IRR = 18.02%

   Alternatively, on your financial calculator, solve for IRR: $-50-\frac{65-2}{1+\text{IRR}}+\frac{2(70+2)}{(1+\text{IRR})^2}=0$

Calculating Dollar-Weighted Return With the TI Business Analyst II Plus®		
Key Strokes	Explanation	Display
[CF] [2nd] [CLR WORK]	Clear CF Memory Registers	CF0 = 0.00000
50 [+/–] [ENTER]	Initial cash inflow	CF0 = –50.00000
[↓] 63 [+/–][ENTER]	Period 1 cash inflow	C01 = –63.00000
[↓] [↓] 144 [ENTER]	Period 2 cash outflow	C02 = 144.00000
[IRR] [CPT]	Calculate IRR	IRR = 18.02210

2. **D** HPR_1 = (65 + 2) / 50 – 1 = 34%, HPR_2 = (140 + 4) / 130 – 1 = 10.77%

   time-weighted return = $[(1.34)(1.1077)]^{0.5}$ – 1 = 21.83%.

3. **A** Treynor measures:

$$T_{ABC}=\frac{0.15-0.05}{1.25}=0.08=8$$

$$T_{RST}=\frac{0.18-0.05}{1.00}=0.13=13$$

$$T_{JKL}=\frac{0.25-0.05}{1.20}=0.1667=16.7$$

$$T_{XYZ}=\frac{0.11-0.05}{1.36}=0.0441=4.4$$

   The following table summarizes the results:

Fund	*Treynor Measure*	*Rank*
ABC	8.00%	3
RST	13.00%	2
JKL	16.67%	1
XYZ	4.41%	4

4. **C** CAPM Returns:

$R_A = 4 + 0.91(8.6 - 4) = 8.19\%$
$R_B = 4 + 0.84(8.6 - 4) = 7.86\%$
$R_C = 4 + 1.02(8.6 - 4) = 8.69\%$
$R_D = 4 + 1.34(8.6 - 4) = 10.16\%$

	Fund A	*Fund B*	*Fund C*	*Fund D*
Alpha	8.25% – 8.19% = +0.06	7.21% – 7.86% = –0.65%	9.44% – 8.69% = +0.75%	10.12% – 10.16% = –0.04%
Ranking	2	4	1	3

5. **A** Sharpe's style analysis measures performance relative to a passive benchmark of the same style.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Hedge Funds

Topic 71

Exam Focus

The topic examines two decades of hedge fund performance. Significant events that shaped the hedge fund industry are discussed, including the growth of institutional investments. Different hedge fund strategies are explained, along with the continuing growth of assets under management. Performance is analyzed to see if the rewards justify the risks, and performance is compared with the broad equity markets. The performance of top fund managers is also compared to the performance across the hedge fund industry.

Characteristics of Hedge Funds

LO 71.1: Describe the characteristics of hedge funds and the hedge fund industry, and compare hedge funds with mutual funds.

There are important distinctions between hedge funds and mutual funds. Hedge funds are private, much less regulated investment vehicles, not available to the general public. On the other hand, mutual funds are more structured and regulated. Hedge funds are highly leveraged, and managers obtain profits from both long and short positions. Hedge fund managers tend to take large bets based on perceived relative price discrepancies of assets.

Privacy is a hallmark of hedge funds. There is little transparency in the hedge fund industry because managers do not want their methods copied. A hedge fund charges a fixed management fee plus a healthy share of new profits from the fund, generally around 10–20%.

Evolution of the Hedge Fund Industry

LO 71.2: Explain biases that are commonly found in databases of hedge funds.

LO 71.3: Explain the evolution of the hedge fund industry and describe landmark events that precipitated major changes in the development of the industry.

LO 71.4: Evaluate the role of investors in shaping the hedge fund industry.

Historical data on hedge fund performance was difficult to obtain prior to the early 1990s. In early 1994, dramatic losses triggered by a Federal Reserve change in interest rate policy had a large impact on hedge fund performance reporting. This prompted the development of hedge fund databases so that participants could better obtain and analyze hedge fund performance.

Assets under management have increased 10 times from 1997 to 2010 as the number of funds has quadrupled. There are some hedge funds that do not participate in commercial databases, which impacts aggregate hedge fund performance. Thus, there is **selection bias**, also known as **self-reporting bias**, contained in hedge fund databases.

There is evidence that suggests that selection bias in large hedge fund databases is actually small. The average return of funds-of-hedge funds (FOHF), comprised of managers who theoretically invest across all hedge funds, not just funds reported to commercial databases, is highly correlated to the average return of hedge funds in commercial databases.

However, there are still concerns about possible measurement errors and various biases in reported hedge fund returns. The consensus is that hedge fund index returns became increasingly reliable beginning in 1996. Prior to 1996, looking at the period from 1987 to 1996, 27 large hedge funds substantially outperformed the S&P 500 index. The outperformance is high, which is more than enough to account for any measurement biases.

The collapse of Long-Term Capital Management (LTCM) in 1998 was a watershed event in the hedge fund industry. It was a reminder that higher returns are accompanied by higher risk. The LTCM collapse had a much greater effect on hedge fund performance compared to equity performance.

The time period of 2000 to 2001 brought the dot-com bubble collapse. During this period, the hedge fund industry experienced a 20% net asset inflow and there was a major shift in the hedge fund industry structure. Hedge funds outperformed the S&P 500 with half of the S&P 500 standard deviation. As a result, institutional investors poured money into hedge funds.

From 1999 to 2007, hedge funds' assets under management went from $197 billion to $1.39 trillion. Investors in hedge funds thus shifted from exclusively private wealth to institutions, including foundations, endowments, pension funds, and insurance companies. Evidence suggests that these institutional investors were rewarded from 2002 to 2010 with high returns, due in large part to bearing credit and emerging market risks.

Alpha-Beta Separation

LO 71.5: Explain the relationship between risk and alpha in hedge funds.

Alpha is a risk-adjusted measure of return often used to assess the performance of active managers. It is the return in excess of the compensation for risk. It is important to identify how much of a strategy's return results from risk (i.e., beta) and how much results from active management (i.e., alpha). This is known as **distinguishing alpha and beta**. A manager who uses statistical techniques, quantitative tools, and benchmarking to discern whether high returns are the result of the superior performance of an active manager or a function of bearing high levels of systematic risk is attempting to distinguish alpha from beta.

A hedge fund may attempt to independently manage alpha and beta. The firm may manage beta exposure while separately managing the portfolio's alpha. This is known as **separating alpha and beta**. Managers can use investment tools to pursue alpha while sustaining a target

beta for the portfolio. Managers typically seek to limit beta while trying to optimize alpha. Derivatives are often used to minimize or eliminate undesired systematic risk.

For example, assume a manager's benchmark is the S&P 500. He would like to pursue opportunities that increase alpha, but the result is beta exposure different from the benchmark. He can use futures contracts to hedge all systematic risks other than exposure to the S&P 500 such that the portfolio's beta relative to the S&P 500 is 1.0. He does this while simultaneously pursuing an alpha optimizing strategy. In this way, he is independently managing, or separating, alpha from beta.

Hedge Fund Strategies

LO 71.6: Compare and contrast the different hedge fund strategies, describe their return characteristics, and describe the inherent risks of each strategy.

Managed Futures and Global Macro

Managed futures funds focus on investments in bond, equity, commodity futures, and currency markets around the world. Systematic trading programs are used which rely on historical pricing data and market trends. A high degree of leverage is employed because futures contracts are used. With managed futures, there is no net long or net short bias.

Many managed futures funds are market timing funds, which switch between stocks and Treasuries. When both short and long positions are considered, the payoff function of this strategy is similar to a lookback straddle, which is a combination of a lookback call option and a lookback put option. The lookback call option gives the owner the right to purchase the underlying instrument at the lower price during the call option's life, while the lookback put option gives the owner the right to sell the underlying instrument at the highest price during the put option's life.

Global macro fund managers make large bets on directional movements in interest rates, exchange rates, commodities, and stock indices. They are dynamic asset allocators, betting on various risk factors over time.

Both managed futures and global macro funds have *trend following* behavior (i.e., directional styles). Global macro funds do better during extreme moves in the currency markets. Both of these strategies are essentially *asset allocation* strategies, since the managers take opportunistic bets in different markets. They also both have a low return correlation to equities.

Merger/Risk Arbitrage and Distressed Securities

Merger (or risk) arbitrage strategies try to capture spreads in merger/acquisition transactions involving public companies, following public announcement of a transaction. The primary risk is **deal risk**, or the risk that the deal will fail to close.

Examining merger arbitrage returns, the largest negative monthly returns in this strategy are after the S&P 500 index has had a large negative return. This equates to being long deal risk. The logic is that when the market has a large decline, mergers have a greater tendency to be called off.

Distressed hedge funds is another event-driven hedge fund style. This strategy invests across the capital structure of firms that are under financial or operational distress, or are in the middle of bankruptcy. The strategy tends to have a long bias. With this strategy, hedge fund managers try to profit from an issuer's ability to improve its operation, or come out of a bankruptcy successfully.

A key feature of the strategy is long exposure to credit risk of corporations with low credit ratings. A good proxy for these types of returns is publicly traded high-yield bonds since the correlation between the DJCS Distress index and high-yield bonds is 0.55.

In sum, both of these event-driven strategies exhibit nonlinear return characteristics, since tail risk appears under extreme market conditions. With merger arbitrage, the tail risk is a large drop in equity investments. With distressed hedge funds, the tail risk is a big move in short-term rates. Unlike trend following strategies, event-driven funds are hurt by extreme market movements.

Fixed Income Arbitrage

Fixed income arbitrage funds attempt to obtain profits by exploiting inefficiencies and price anomalies between related fixed income securities. The fund managers try to limit volatility by hedging exposure to interest rate risk. An example of this strategy is leveraging long/short positions in fixed income securities that are related—mathematically or economically.

The sectors traded under fixed income arbitrage include:

- Credit yield curve relative value trading of swaps, government securities, and futures.
- Volatility trading using options.
- Mortgage-backed securities arbitrage.

A **swap spread trade** is a bet that the fixed side of the spread will stay higher than the floating side of the spread, and stay in a reasonable range according to historical trends. With **yield-curve spread trades**, the hope is that bond prices will deviate from the overall yield curve only in the short term, and will revert to normal spreads over time. **Mortgage spread trades** are bets on prepayment rates, while **fixed income volatility trades** are bets that the implied volatility of interest rate caps have a tendency to be higher than the realized volatility of, for example, a Eurodollar futures contract. **Capital structure** or **credit arbitrage trades** try to capitalize on mispricing among different types of securities (e.g., equity and debt).

Convertible Arbitrage

Convertible arbitrage funds attempt to profit from the purchase of convertible securities and the shorting of corresponding stock, taking advantage of a perceived pricing error made in the security's conversion factor. The number of shares shorted is based on a delta neutral or

market neutral ratio. The plan is for the combined position to be insensitive to underlying stock price fluctuations under normal market conditions.

The return to convertible arbitrage hedge funds comes from the liquidity premium paid by issuers of convertible bonds to hedge fund managers, for holding convertible bonds and managing the inherent risk by hedging the equity part of the bonds.

Long/Short Equity

Long/short equity funds take both long and short positions in the equity markets, diversifying or hedging across sectors, regions, or market capitalizations. Examples are shifts from value to growth, small- to mid-cap stocks, and net long to net short. Trades in equity futures and options can also take place.

Thirty to forty percent of hedge funds are long/short. Long/short managers are stock pickers with varying opinions and abilities, so performance tends to be very idiosyncratic. Underpriced or under-researched stocks are favored, as are small stocks, on the long side. On the short side, low liquidity makes small stocks and foreign stocks less attractive. Long/short equity funds have directional exposure to the overall market and also have exposure to long small-cap/short large-cap positions.

Dedicated Short Bias

Funds with a dedicated short bias tend to take net short positions in equities. Sometimes the short position strategy is implemented by selling forward. To manage risk, managers take offsetting long positions and stop-loss positions. The returns are negatively correlated with equities.

Emerging Markets

Emerging market funds invest in currencies, debt, equities, and other instruments in countries with emerging or developing markets. These markets are usually identified in terms of gross national product (GNP) per capita. China, India, Latin America, Southeast Asia, parts of Eastern Europe, and parts of Africa are examples of emerging markets. These funds have a long bias because it is more difficult to short securities in emerging markets.

Equity Market Neutral

When reviewing equity market neutral hedge fund strategies, research shows that there is not one common component (or risk factor) in their returns. Different funds utilize different trading strategies, but they all have a similar goal of trying to achieve zero beta(s) against a broad set of equity indices.

Hedge Fund Performance

LO 71.7: Describe the historical portfolio construction and performance trend of hedge funds compared to equity indices.

Twenty-seven large hedge funds were identified in 2000, and research has been done to determine if these hedge funds are truly a separate asset class, not correlated to equity or bond indices. Hedge fund returns were regressed against an 8-factor model used to analyze hedge fund performance. Findings were that hedge fund portfolios had no significant exposure to stocks and bonds. As an equally weighted portfolio, this portfolio of 27 top performing hedge funds had a large alpha of 1.48% per month. There was a persistent exposure to emerging markets, but other factor betas showed a lot of variability. Also, alpha declined over time, and there was not a persistent directional exposure to the U.S. equity market. Measurement bias may have affected these results somewhat.

Alternatively, a strategy of investing in a portfolio of the top 50 large hedge funds was tested using data from 2002 to 2010. Two test portfolios were constructed:

- The first test portfolio attempted to mimic performance of a strategy of investing in the top funds in equal dollar amounts, and rebalancing at the end of each calendar year. The funds were selected based on the assets under management at year-end 2001.
- A similar portfolio was constructed using top funds based on year-end 2010, rather than 2001.

For the first portfolio, the intent was to give a lower and upper bound of performance which investors could achieve, by just following a strategy of investing equally in the top 50 large hedge funds, and rebalancing yearly. The second portfolio was "foresight assisted."

In evaluating performance characteristics, the first portfolio did not have a significant alpha, while the foresight-assisted portfolio had a monthly alpha of 0.53%, and was statistically significant at the 1% level. Compared to hedge fund returns prior to 2002, the decline in alpha is consistent with the thinking that there is more competition in the hedge fund industry. It should, however, be noted that there is no significant negative alpha.

Looking at the top 50 hedge funds versus all hedge funds, the top 50 portfolios (both versions) demonstrated statistically significant alpha relative to the DJCSI and HFRI hedge fund indices. The strategy of buying large hedge funds appears to deliver superior performance compared to just investing in hedge fund indices.

During the 2002 to 2010 time period, the top 50 hedge fund portfolios (with the exception of the foresight-assisted portfolio), and the two broad hedge fund indices, DJCSI and HFRI, all outperformed the equity market, as measured by the S&P 500 index. In sum, analysis of large hedge funds shows that managers are still delivering alpha return relative to peers, and also have low exposure to the U.S. equity market. These factors continue to attract institutional investors.

Convergence of Risk Factors

LO 71.8: Describe market events that resulted in a convergence of risk factors for different hedge fund strategies, and explain the impact of such a convergence on portfolio diversification strategies.

Theoretically, diversification among hedge fund strategies should protect investors, but there are certain events that affect all, or mostly all, strategies, as they all undergo stress at the same time. Portfolio diversification implodes, and seemingly diverse hedge fund portfolios *converge* in terms of risk factors during times of stress.

The first recorded major market event for hedge funds was in March and April of 1994 when unexpected changes in interest rate policy were set by the Federal Reserve. This caused two months of losses by seven of the ten style-specific sub-indices in the DJCS family. Exceptions were short sellers and managed futures funds. Merger arbitrage funds earned a positive return in March, while equity market neutral funds had a positive return in April.

Another major event was in August 1998 right before the collapse of LTCM. Eight of the ten niche DJCS style sub-indices had large losses. Short sellers and managed futures funds avoided losses. The losses occurred primarily due to market-wide liquidation of risky assets and the high amount of leverage on LTCM's balance sheet.

With hedge fund investing, leverage has a magnifying effect on gains and losses, and risk is on both sides of the balance sheet. There were events prior to the 2007–2009 financial crisis that illustrated how much a market-wide funding crisis can significantly impair leveraged positions. In August 2007, for the first time, all nine specialist style sub-indices lost money. The only positive return was from short sellers. During the peak of the financial crisis from July to October 2008, July to September brought losses for all hedge fund styles (excluding short sellers). When leveraged positions are forced to liquidate, losses can be high.

The point is that when there is a market-wide funding crisis, it is difficult to mitigate risk by simply spreading capital among different hedge fund strategies. There is significant credit-driven tail risk in a hedge fund portfolio. The use of managed futures may be a partial solution—it has been a strategy with a convex performance profile relative to other hedge fund strategies. Hedge fund investors need to consider portfolio risks associated with dramatic market events.

Risk Sharing Asymmetry

LO 71.9: Describe the problem of risk sharing asymmetry between principals and agents in the hedge fund industry.

In the hedge fund industry, risk sharing asymmetry between the principal (investor) and the agent (fund manager) is a concern due to variable compensation schemes.

The problem occurs when the incentive fee that a hedge fund manager is entitled to, typically 15–20% of new profits [profits above a high water mark (HWM)], encourages a fund manager to take outsized risks. This tends to increase the future loss-carried-forward if

and when these bets fail. If the fund fails, the same fund manager can start up a new hedge fund.

However, there is an opportunity cost involved in cases where a hedge fund manager closes a fund. It is costly in terms of harming the track record of the manager and affects reputation risk of both the manager and the fund company. All things considered, this cost does not totally mitigate the basic principal/agent conflict.

Investors may be best served to invest in funds for which the fund managers invest a good portion of their own wealth. As much as this issue has been discussed, the basic structure of how fund managers are compensated has not changed.

Impact of Institutional Investors

LO 71.10: Explain the impact of institutional investors on the hedge fund industry and assess reasons for the growing concentration of assets under management (AUM) in the industry.

As mentioned earlier, beginning in 2000, institutional investor funds flowed into hedge funds, and assets under management in the hedge fund industry grew from $197 billion at 1999 year-end to $1.39 trillion by 2007 year-end. Institutional investors were rewarded for allocating capital to a much higher fee environment. Three hedge fund performance databases, DJCSI, HFRI, and HFRFOFI, respectively, reported cumulative performance of 72.64%, 69.82%, and 38.18% from the 2002 to 2010 time period, compared to the S&P 500 index return of 13.5%. The S&P 500 index had a 16% standard deviation during that period, versus annualized standard deviations of return of 5.84%, 6.47%, and 5.51%, for the respective hedge fund indices.

With the increase of institutional investment came greater demands on hedge fund management for operational integrity and governance. Some institutional investors were seeking absolute performance, while others were seeking alternative sources of return beyond equities. There is some concern that there is no identifiable alpha associated with hedge fund investing, so it is increasingly important that hedge fund managers differentiate themselves from their peers.

Key Concepts

LO 71.1

Hedge funds are private investments and have very little financial regulation. They tend to be highly leveraged, and managers make large bets. On the other hand, mutual funds are regulated and more structured.

LO 71.2

There are some hedge funds that do not participate in commercial databases, which impacts aggregate hedge fund performance. Thus, there is selection bias contained in hedge fund databases.

LO 71.3

There have been major events affecting the hedge fund industry, including large losses following a change in Fed policy in 1994, the LTCM collapse in 1998, and the dot-com collapse in 2001.

LO 71.4

From 1999 to 2007, investors in hedge funds shifted from exclusively private wealth to institutions, including foundations, endowments, pension funds, and insurance companies.

LO 71.5

Alpha is the return in excess of the compensation for risk. Beta is a measure of the systematic risk of the security or portfolio relative to the market as a whole. Firms may independently manage alpha and beta. This is known as separating alpha and beta. Managers can use investment tools to pursue alpha while sustaining a target beta for the portfolio.

LO 71.6

Managed futures funds focus on investments in bond, equity, commodity futures, and currency markets around the world. The payoff function of this strategy is similar to a lookback straddle.

Global macro managers make large bets on directional movements in interest rates, exchange rates, commodities, and stock indices, and do better during extreme moves in the currency markets.

Merger arbitrage funds bet on spreads related to proposed merger and acquisition transactions, and perform poorly during major market declines.

Distressed hedge funds invest across the capital structure of firms that are under financial or operational distress, or are in the middle of bankruptcy. The strategy tends to have a

long-bias. These hedge fund managers try to profit from an issuer's ability to improve its operation, or come out of a bankruptcy successfully.

Fixed income arbitrage funds try to obtain profits by exploiting inefficiencies and price anomalies between related fixed income securities. Their performance is correlated to changes in the convertible bond default spread.

Convertible arbitrage funds attempt to profit from the purchase of convertible securities and the shorting of corresponding stock.

Long/short equity funds take both long and short positions in the equity markets, diversifying or hedging across sectors, regions, or market capitalizations, and have directional exposure to the overall market and also have exposure to long small-cap/short large-cap positions.

Dedicated short bias funds tend to take net short positions in equities, and their returns are negatively correlated with equities.

Emerging market funds invest in currencies, debt, equities, and other instruments in countries with emerging or developing markets.

Equity market neutral funds attempt to achieve zero beta(s) against a broad set of equity indices.

LO 71.7

The top 50 hedge funds demonstrated statistically significant alpha relative to the DJCSI and HFRI hedge fund indices. The strategy of buying large hedge funds appears to deliver superior performance compared to just investing in hedge fund indices. Hedge fund managers are still delivering alpha relative to peers, and also have low exposure to the U.S. equity market.

LO 71.8

Diversification among hedge fund strategies may not always be effective due to the convergence of risk during times of extreme market stress. There is significant credit-driven tail risk in a hedge fund portfolio. The use of managed futures may be a partial solution—it has been a strategy with a convex performance profile relative to other hedge fund strategies. Hedge fund investors need to consider portfolio risks associated with dramatic market events.

LO 71.9

In the hedge fund industry, risk sharing asymmetry between the principal (investor) and the agent (fund manager) is a concern due to variable compensation schemes.

LO 71.10

Institutional investors flocked to hedge funds beginning in 2000. With the increase of institutional investment came greater demands on hedge fund management for operational integrity and governance.

Concept Checkers

1. What critical shift occurred in the hedge fund industry following the collapse of Long-Term Capital Management (LTCM) in 1998 and the dot-com bubble burst in 2001?
   A. There was a significant drop in assets under management in the hedge fund industry.
   B. There was a large influx of institutional investors investing in hedge funds.
   C. Reporting within the hedge fund industry became more regulated than mutual funds.
   D. There was a significant increase in hedge fund failures.

2. Which of the following hedge fund strategies would be characterized as an "asset allocation" strategy that performs best during extreme moves in the currency markets?
   A. Global macro.
   B. Risk arbitrage.
   C. Dedicated short bias.
   D. Long/short equity.

3. Comparing hedge fund performance during the time period 2002–2010 to earlier time periods, how would monthly alpha compare, if looking at large hedge funds?
   A. Alpha was higher in the 2002–2010 time period.
   B. Alpha remained constant over both time periods.
   C. A "foresight-assisted" portfolio did not have a statistically significant alpha during the 2002–2010 time period.
   D. There was a decline in alpha in the 2002–2010 time period.

4. Jamie Chen, FRM, is considering investing a client into distressed hedge funds. Which of the following investments would serve as the best proxy for the types of returns to expect?
   A. Convertible bonds.
   B. Small-cap equities.
   C. Managed futures.
   D. High-yield bonds.

5. What would be an ideal approach for a hedge fund investor who is concerned about the problem of risk sharing asymmetry between principals and agents within the hedge fund industry?
   A. Focus on investing in funds for which the fund managers have a good portion of their own wealth invested.
   B. Focus on diversifying among the various niche hedge fund strategies.
   C. Focus on funds with improved operational efficiency and transparent corporate governance.
   D. Focus on large funds from the "foresight-assisted" group.

Concept Checker Answers

1. **B** During the time period following the dot-com collapse, hedge funds outperformed the S&P 500 with a lower standard deviation, which attracted institutional investment.

2. **A** A global macro fund does better if there are extreme moves in the currency markets. Along with managed futures, global macro is an asset allocation strategy. Managers take opportunistic bets in different markets. The strategy has a low correlation to equities.

3. **D** Comparing the two different time periods, there was a decline in alpha due to more competition in the hedge fund industry.

4. **D** Distressed hedge funds have long exposure to credit risk of corporations with low credit ratings. Publicly traded high-yield bonds are a good proxy for the returns to expect.

5. **A** The incentive fee structure within the hedge fund industry has not really changed over the years, and there is incentive for managers to take undue risks in order to earn fees. Thus, there should be a focus on investing in funds for which the fund managers have a good portion of their own wealth invested.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Performing Due Diligence on Specific Managers and Funds

Topic 72

Exam Focus

This topic emphasizes the reasons investors should perform due diligence on potential investments. It provides a thorough list of items to consider in the due diligence process. For the exam, understand in detail the steps involved in evaluating a manager, a fund's risk management process, and a fund's operational environment.

Past Fund Failures

LO 72.1: Identify reasons for the failures of funds in the past.

Investors should be familiar with the reasons past funds have failed to ensure they can avoid investing in a failing fund. Following is a concise list of reasons past funds have failed.

1. **Poor investment decisions.** Could be a series of decisions ("domino effect") or a very calculated risk on a specific investment that backfired.

2. **Fraud.** Fraud could occur in several forms including accounting (e.g., misstating asset book values or misstating income), valuation (e.g., misstating asset market values), and theft of funds.

3. **Extreme events.** Events occurring that would otherwise occur with very low probability or were unexpected (e.g., market crashes).

4. **Excess leverage.** Related to making poor investment decisions. Leverage goes both ways. That is, it magnifies gains but also magnifies losses.

5. **Lack of liquidity.** Too many capital withdrawals and redemptions to honor at once, thereby creating a squeeze on cash flow and an inability to meet all capital withdrawals and redemptions.

6. **Poor controls.** Closely related to fraud. Lack of supervision could result in excessive risks being taken that lead to losses large enough to bankrupt the fund.

7. **Insufficient questioning.** Often in a committee-style decision-making process, there may be a dominant member who sways the decision and/or members who are afraid to voice any valid concerns over information they have discovered that would question the merits of the investment manager and/or investment. Ideally, all due diligence team members should be encouraged to play the role of "devil's advocate" when appropriate and raise reasonable concerns as early as possible, especially before they reach the committee stage.

8. **Insufficient attention to returns.** Investment funds attempting to reduce operational risk sometimes overcompensate by implementing excessive controls and may end up bearing too many expenses and not generating enough returns. Ideally, there is a healthy balance between generating strong returns while taking on a reasonable level of risk.

Due Diligence Elements

LO 72.2: Explain elements of the due diligence process used to assess investment managers.

Prior to investing, an investor performs due diligence on a potential investment manager, which involves assessing the manager, the fund, and the investment strategy. Information such as the investment background, manager's reputation (e.g., education, employers), and past performance have always been key considerations but are insufficient on their own.

An additional element of due diligence involves assessing the investment process and risk controls. The starting point is a review of the fund's prospectus or offering memorandum. Additionally, an attribution analysis could be performed to determine how the returns were generated. Were they generated through the skill and control of the manager, luck, and/or factors beyond the manager's control? In addition, was the amount of return in line with the amount of risk taken?

Another related element is assessing the fund's operations and business model. In general, are there internal controls and policies in place to preserve the investors' funds? Specifically, are the controls in place sufficiently robust to detect and prevent fraudulent activities or are limits imposed on managers to seek higher level approval for transactions exceeding a certain dollar amount or frequency? Is there appropriate segregation of duties between the front office and the back office? What is the process and frequency of asset valuations? What is the fee structure and are there any additional fees after a specific threshold? Are there any limitations or blackout periods on redemptions?

In the end, investors should assess potential managers and their investment strategies with an objective and unbiased mind. They should not get caught up with a manager's past successes.

Manager Evaluation

LO 72.3: Identify themes and questions investors can consider when evaluating a manager.

Manager evaluation is not a task that should be taken lightly by potential investors. This process can be broken down into four areas including strategy, ownership, track record, and investment management.

Strategy

General questions regarding a manager's strategy may include:

- Does the manager follow a particular investment style (e.g., growth, value)?
- Are there any current "trends" in the fund or specializations in specific securities, industries, or sectors?
- How has the fund changed its investment style or rebalanced its holdings over the past year? What changes are contemplated in light of anticipated market conditions?
- What is the extent of turnover and liquidity in the fund? What market signals are used to determine whether to exit or enter a position?
- What mechanisms are in place to limit any potential losses in the fund?
- To what extent is quantitative analysis and modeling utilized in the investment process? Have any models been developed or tested to date?
- Are short sales used to generate excess profits or to hedge? How successful or detrimental have they been so far?
- Are derivatives used in the portfolio? If so, are they used for hedging or speculative purposes?
- How does the trade execution process work? Does a central trading desk exist for maximum efficiency?
- What is the extent of any investment in private company securities and their role in the overall investment strategy?
- What is the tradeoff between maximizing current returns versus long-term fund growth?
- Has the fund ever been closed or provided investors with a return of capital?

Ownership

Ownership interests often help align the interests of the investment team and the investors. They can be useful in attracting and maintaining quality staff, thereby enhancing and/or continuing to generate strong investment returns for investors.

Therefore, potential investors should inquire as to whether any members of the investment team (e.g., traders, portfolio managers, research analysts) have ownership interests in the firm.

Track Record

Specific questions about the manager's and fund's track records may include:

- How does the past performance of the manager and/or fund compare to its peers and/or funds that follow the same or similar investment philosophy?
- Has past performance been audited or verified by a third party?
- Is there sufficient performance history to perform trend and/or attribution analysis? How did the manager or fund perform during market downturns?
- What were the investment returns relative to the size of the investment assets?
- Are most or all of the staff on the investment team that generated those past results still employed by the firm?

Investment Management

Inquiries during manager interviews may include:

- What is/was the manager's investment strategy for generating excess returns?
- How did the manager cope with tough market periods?

Reference checks on managers could include the following individuals:

- Former employers: Was the manager a leader or follower? Proactive or reactive? A team player or individualist?
- Current and former colleagues, clients, and other independent parties: Ensure consistency but if there are mixed reviews, follow up for explanations and/or obtain clarification from the manager.
- Current and former investors: What good and bad investment experiences did they have with the manager?

Background checks on managers may include the following questions/activities:

- Obtaining comprehensive background check reports on the manager.
- Review the Form ADV filed by the manager with the SEC and state securities authorities. It contains general information about the business as well as more detailed information such as fees, services provided, conflicts of interest, and background of key personnel.
- Has the manager consistently demonstrated herself to be a person of integrity? This could be verified by examining public databases and the SEC website to look for any past or current instances of litigation or criminal behavior.
- Has the manager demonstrated strong personal financial responsibility? This could be verified by examining personal credit reports and bankruptcy reports.
- Are the manager's stated representations accurate? This could be verified by inquiring with auditors and brokers who are currently working with the manager or have worked with the manager in the past.
- What is the extent of the manager's involvement in any related party transactions?

Risk Management Evaluation

LO 72.4: Describe criteria that can be evaluated in assessing a fund's risk management process.

A proper risk management process should contain an assessment of the following areas: risk, security valuation, portfolio leverage and liquidity, tail risk exposure, risk reports, and consistency of the fund terms with the investment strategy.

Risk

- Assess the applicable systematic risk factors (i.e., regular market risks common to most or all funds) and unsystematic risk factors (i.e., risks specific to the manager, fund, or strategy).
- Determine whether written policies and procedures exist regarding measuring and monitoring risk.
- Determine whether a risk committee exists that would receive such measurements. If so, how often are they reported?
- Evaluate the extent of the risk management culture among the various types of employees. For example, how actively involved are employees with managing and mitigating the firm's risks on a day-to-day basis?
- Assess the information technology resources used to quantify the risks. For example, are they reliable and do they measure items consistently between traders and portfolio managers?
- Identify the existence and structure of any risk models. What are their inputs and assumptions? Have the models been tested and are they robust?

Security Valuation

- Identify the proportion of fund assets that are objectively valued through reliable market prices versus those that are more subjectively valued by the broker or through simulation.
- Examine the independence of valuations. Is valuation performed by the fund administrator (generally more independent) or by the fund manager (generally less independent)?
- Determine if prices may be overridden for valuation purposes. If so, by whom? Is there documentation or an approval process?

Portfolio Leverage and Liquidity

- Assess the sources of leverage as well as the current and historical levels of leverage.
- Calculate the current level of liquidity and observe how it has changed over time. The current level is especially relevant because of the impact on portfolio investment capacity and whether it can take on more investment capital.
- Within a stated investment strategy, excessive leverage and/or illiquidity could generate actual returns that are significantly different than expected (i.e., no longer comparing apples to apples), thereby requiring an adjustment in expected returns.

Exposure to Tail Risk

- Analyze information about the fund to conclude whether the fund's return distribution possesses skewness or kurtosis.
- Discuss the possibility of tail risk with the manager and determine whether the manager has sufficiently mitigated the risk or whether further action is required by the investor.

Risk Reports

- Review risk reports prior to investing in the fund. Investors should receive these risk reports on a regular basis (e.g., monthly, quarterly, annually) whether they are prepared in-house or by a third party.
- Analyze key risk metrics and compare them to other similar funds for benchmarking purposes and for determining if any unusual risks exist in the fund.

Consistency of the Fund Terms with the Investment Strategy

- Examine the general fee structure of the fund and determine whether it is consistent with similar funds.
- Identify the existence of any additional fees after a specific threshold (e.g., high-water mark, hurdle rate).
- Evaluate whether high fees are being paid to managers in search of market alpha (fair) as opposed to beta (unfair).
- Identify the existence of any limitations or blackout periods on redemptions.

Operational Due Diligence

LO 72.5: Explain how due diligence can be performed on a fund's operational environment.

Investors should focus on several key areas when performing operational due diligence on a fund. The focus areas are internal control assessment, documents and disclosure, and service provider evaluation.

Internal Control Assessment

A starting point in due diligence is examining the qualifications and attitudes of the personnel. For instance, does the CEO believe in controls and compliance with the rules? An analyst must also assess whether the internal control staff have sufficient technical and work experience to perform their compliance duties properly. Have they been properly trained and do they continue to expand their skills in compliance? Some assurance may be required regarding whether the back and middle office managers are sufficiently experienced in performing supervisory duties. Finally, background checks on critical internal control staff members might be required.

Examining the fund's policies and procedures may also be useful. Related documents may cover areas such as trading, derivatives usage, and transaction processing. One drawback is that these documents tend to be general and only demonstrate the intention to have a strong control environment. In other words, merely reading the documents provides little assurance that the policies and procedures are actually being followed or are effective. It is

usually a good sign if a fund has been proactive and obtained an audit report and opinion on the effectiveness of its controls. If this report is available, it should be reviewed.

The due diligence process should include an examination of the in-house or outsourced compliance system that is in place. Examples of specific items to consider include the code of ethics (if one exists) and any restrictions on employee trading and related-party transactions.

There should be an investigation into how the funds deal with counterparty risk arising from OTC derivatives and other counterparties. Is such risk mitigated by dealing with more than one counterparty? Are the counterparties monitored for risk on a daily basis?

Finally, there should be an assessment as to the effectiveness of corporate governance. Is it pervasive throughout the organization? Are examples of internal control "breaches" followed up with appropriate actions to remedy and prevent future recurrence?

Documents and Disclosure

As part of the due diligence process, investors must confirm with the fund's legal counsel its involvement in preparing the original version of the fund documents as well as any subsequent revisions. The investor should also confirm if the law firm remains as the fund's legal counsel. A physical check of the documents should be made to look for any changes made after the date indicated on the documents.

The investor should corroborate the terms of the offering memorandum by examining other documents such as the Form ADV, subscription agreement, and investment management agreement. Consistency is important here. Terms relating to fees, redemption rights, liquidity, and lockups should be examined closely and clarified with the manager if required.

Conflicts of interest that are disclosed in the offering memorandum should be scrutinized carefully. Lack of clarity in the disclosure may be a red flag and warrant further discussion with the manager and/or require independent information.

Similarly, lack of clarity or sufficiency in the disclosure of risks may warrant further investigation. The discussion of very general or irrelevant risk factors may be cause for concern.

The focus of any due diligence should be on the manager. As a starting point, the potential investor should determine the extent of the manager's authority. Are the provisions very broad (potentially more risky) or quite specific? Is the manager subject to limitations on the amount of leverage employed or on the percentage of the fund invested in specific securities, sectors, or industries? Can the manager be indemnified for his actions outside of fraud, gross negligence, or malicious intent? Additionally, there should be a consideration of the manager's reporting duties to investors (e.g., audited financial statements, disclosure of the tax treatment of the fund's income and transactions).

In analyzing the financial statements, the investor should begin by ensuring the audit opinion is unqualified (i.e., the auditor believes the financial statements contain no material misstatements). The balance sheet and income statement should be examined for

consistency with the fund's investment strategy (e.g., a high leverage fund should have high interest expense on the income statement and high liabilities on the balance sheet). Any inconsistencies should be discussed with the manager on a timely basis. In addition, the footnotes (which are also audited) should be examined carefully since they provide more detailed information on key items (e.g., contingent liabilities, related-party transactions) than the corresponding financial statements.

Fees paid to the manager by the fund should be scrutinized and recalculated. They should be corroborated with the offering memorandum. Specifically, there should be a check of any incentive fees paid in loss years.

Finally, there should be a check for the level of net contributions to the fund by the general partner. Any fund withdrawals should be questioned.

Service Provider Evaluation

Third-party service providers may be hired by a fund for trade execution, information technology, valuation, verification, and asset safeguarding purposes.

A starting point for assessing the actual service providers is to examine the internal control letters issued by its auditors and its audited financial statements. Further due diligence could be performed through in-person discussions regarding the service provider's role.

Business Model and Fraud Risk

LO 72.6: Explain how a fund's business model risk and its fraud risk can be assessed.

In addition to the previous due diligence, potential investors need to closely examine the fund to ensure that the risks associated with its business model and potential fraud are not excessive.

Business Model Risk

Evaluating business model risk requires assessing whether managers know how to operate the business as well as generate high returns. Typical risks, potentially leading to failure and closure of the fund, include a lack of cash and working capital, a lack of a succession plan, and excessive redemptions in a short period of time.

A fund's business model risk can be assessed by performing the following tasks:

- Examining the nature of the revenues and expenses. For example, are revenue items stable, recurring, or one-time? Can costs be reduced or are they increasing uncontrollably?
- Calculating the percentage of revenues derived from variable incentive or performance fees (that may not materialize in market downturns).
- Assessing the significance of the gap between management fees (revenue) and operating expenses.

- Considering the sufficiency of the amount of working capital (especially cash) in place to cover revenue shortfalls and/or expense overages for a reasonable period of time.
- Determining how frequently budgets are created and for what period of time.
- Determining the fund's breakeven points in terms of assets under management and required performance level. Comparing those amounts to current (actual) and future (projected) amounts.
- Ascertaining if there is sufficient personnel or capacity to increase the fund's investment asset base.
- Ascertaining the existence of key person insurance on relevant individuals and the existence of a succession plan.

Fraud Risk

Fraud risk can always exist even though extensive due diligence has been performed on the manager and fund prior to investing. A fund's fraud risk can be assessed by determining the existence of the following factors:

- Frequent related-party transactions, including trading through a broker or using a valuator who is a related party.
- Frequent instances of illiquidity, including significant concentrations of illiquid investments (especially those that are valued by the manager only).
- Frequent litigation as a defendant, especially regarding claims of fraud.
- Unreasonably high (stated) investment returns.
- Frequent personal trading by the manager of the same or similar securities as those held by the fund.
- Frequent shorting transactions.

Fraud risk may be mitigated by performing the following actions:

- Check the SEC website for any prior regulatory infractions.
- Check court records for any prior litigation and bankruptcy records for examples of financial irresponsibility.
- Inquire with service providers for assurance over their competence and independence from the manager.
- Perform extensive background checks on the manager.

Due Diligence Questionnaire

LO 72.7: Describe elements that can be included as part of a due diligence questionnaire.

Properly designed due diligence questionnaires that are thoroughly and honestly answered by respondents can yield valuable information to a potential investor and may provide a list of concerns that need further assessment. The questionnaire should make the following inquiries:

1. Inquiry into general information on the manager provides a starting point in the due diligence process. Examples of such information include:
   - Confirmation of proper registration with regulatory authorities.
   - Determination of ownership form (e.g., corporation) and structure.
   - Identification of key shareholders.

- Reference checks.
- Information on past performance.
- Business contact information.

2. Inquiry into general information on the fund also is critical. Examples of general information that should be collected include:
   - Fees.
   - Lockup periods.
   - Redemption policies.
   - Primary broker.
   - Fund director.
   - Administrator.
   - Compliance: auditor and legal advisor.
   - Financial: assets under administration, investment capacity, and historical performance (also see financial statements).
   - Historical drawdown levels.

3. Inquiry into execution and trading as well as service providers may provide some insight on the speed and accuracy of transaction processing and the existence of related-party service providers, the latter of which may raise red flags with potential investors as discussed earlier.

4. Inquiry regarding the firm's third-party research policy may be useful to determine a fund's sources of research information, thereby allowing the assessment of the extent and quality of the due diligence performed by the fund in its investment process.

5. Inquiry regarding compliance processes, the existence and degree of involvement of in-house legal counsel, and the existence of anti-money laundering policy and procedures may help provide comfort that the fund and its managers have a desire to operate in an ethical manner and/or within the boundaries of the law.

6. Inquiry into the existence of information regarding disaster recovery and business continuity plans as well as insurance coverage and key person provisions may provide some assurance regarding the stability of the firm and, therefore, the safety of any invested funds.

7. Inquiry into the investment process and portfolio construction provides the potential investor with information required to make an informed decision whether the overall risk and return profile of the fund is consistent with the investor's investment objectives.

8. Inquiry into risk controls such as leverage, liquidity, asset concentrations, portfolio diversification, and market risk factors give the investor a more complete picture of the investment risks and how the managers attempt to manage and mitigate them.

The existence of financial statements, especially if audited with an unqualified opinion, provide objective and historical financial information on the fund that can be used to assess performance. Information on the composition of the invested assets may also be helpful to the potential investor. Finally, interim statements (not necessarily audited) may provide more timely information to make a more current assessment of the fund by the potential investor.

Key Concepts

LO 72.1

Past fund failures can be attributed to poor investment decisions, fraud, extreme events, excess leverage, lack of liquidity, poor controls, insufficient questioning, and insufficient attention to returns.

LO 72.2

The due diligence process for assessing investment managers should include information on the investment background and reputation of the managers and past performance. In addition, there should be an assessment of the fund's investment process, risk controls, operations, and business model.

LO 72.3

In evaluating a manager, investors should consider four broad themes including strategy (e.g., evolution, risk management, quantification, types of investments), ownership, track record (e.g., comparison with peers, independent verification of results), and investment management (e.g., manager interviews, reference checks, background checks).

LO 72.4

Criteria that could be used in assessing a fund's risk management process includes risk (e.g., types, culture, quantification/models), security valuation, portfolio leverage and liquidity, tail risk exposure, risk reports, and consistency of the fund terms with the investment strategy.

LO 72.5

Performing due diligence on a fund's operating environment focuses on:

- Internal control assessment (i.e., qualifications and attitude of personnel, written policies and procedures, compliance system, counterparty risk, effectiveness of governance).
- Documents and disclosure (i.e., confirmations with the fund's legal counsel regarding fund documents, corroborating terms of the offering memorandum, conflicts of interest, disclosure of risks, manager's authority, manager's reporting duties to investors, financial statements, and fees paid to the manager, net contributions/withdrawals by the general partner).
- Service provider evaluation.

LO 72.6

Business model risk can be assessed by considering revenues and expenses (detailed examination), sufficiency of working capital, existence of budgets, computation of breakeven points, ability to increase investment asset base, existence of key person insurance, and existence of a succession plan.

Fraud risk can be assessed by considering the existence of related-party transactions, illiquidity, litigation, unreasonably high (stated) investment returns, personal trading by the manager of the same or similar securities as those held by the fund, and shorting transactions.

LO 72.7

Items to include as part of the due diligence questionnaire include general information on the manager and the fund, execution and trading, service providers, third-party research policy, compliance processes, existence and degree of involvement of in-house legal counsel, existence of anti-money laundering policy and procedures, existence of information regarding disaster recovery and business continuity plans, insurance coverage, key person provisions, details of the investment process and portfolio construction, risk controls, and information contained in the fund's financial statements.

Concept Checkers

1. Based on historical evidence, which of the following factors is least likely to result in the eventual failure of a hedge fund?
   A. Excessive controls in place.
   B. Taking on more systematic risk.
   C. Making decisions in a committee setting.
   D. Materially misstated financial statements.

2. In performing due diligence on a potential investment manager, which of the following factors is the least important for the investor to consider?
   A. Risk controls.
   B. Business model.
   C. Past performance.
   D. Investment process.

3. Which of the following items is least likely to be included as requested information on a due diligence questionnaire?
   A. Insurance coverage.
   B. Returns attribution analysis.
   C. Disaster recovery procedures.
   D. Anti-money laundering policy.

4. Which of the following statements regarding the assessment of a fund's risk management process is correct?
   A. The periodic valuation of a fund's securities is best performed by the fund manager.
   B. The existence of written policies and procedures for internal controls is useful in measuring and monitoring risk.
   C. The risk reports received by investors are preferably prepared by a third-party risk provider instead of by the fund itself.
   D. The key requirement for information technology resources used to quantify the risks is that they measure items consistently.

5. Lisa Tahara, FRM, is considering an institutional investment in a hedge fund that has experienced volatile and generally positive returns in the past. Which of the following considerations about the fund's track record is least relevant for consideration in her investment decision?
   A. Size of investment assets.
   B. Absolute level of past returns.
   C. Verification of returns by a third party.
   D. Employment continuity of the investment team.

Concept Checker Answers

1. **B** If a fund takes on more systematic risk (i.e., regular market risk), it is less likely to result in a failure unless there is a significant market downturn. Taking on more unsystematic risk, however, is more likely to result in a failure. Excessive controls to reduce operational risk may be a good idea but may also result in excessive expenses and insufficient returns, thereby leading to a possible failure of the fund.

   In a committee-style decision-making process, there may be a dominant member who sways the decision and/or members who are afraid to voice any valid concerns. Materially misstated financial statements are a form of accounting fraud, which significantly increases the risk of the eventual failure of a fund.

2. **C** Investors should assess potential managers and their investment strategies with an objective and unbiased mind. They should not be unduly concerned with a manager's past successes given that past performance is not always indicative of future performance. Risk controls, the business model, and the investment process are all fundamental parts of the due diligence process.

3. **B** A returns attribution analysis could be performed to determine how a fund's returns were generated. Return attributions are not generally part of a due diligence questionnaire but such an analysis could subsequently be performed based on some of the information received from the questionnaire. The other items (insurance coverage, disaster recovery procedures, and anti-money laundering policy) are all standard items that would be found in most, if not all, due diligence questionnaires.

4. **D** It is very important for the information technology resources used to quantify risks to measure items consistently. Securities valuation is an important and potentially subjective task, therefore, independence and objectivity is critical. Policies and procedures tend to be general and only demonstrate the intention to have a strong control environment. Their existence alone provides little assurance that they are properly measuring and monitoring risk. In general, the reporting of risk measures is a more objective task and as a result, there is little or no preference for the reporting to be done internally or externally.

5. **B** The absolute level of past returns is least relevant here given the volatile returns in the past. Also, past returns are not an assurance of similar returns in the future. The relative level of returns is more important than the absolute level. Verification of returns by a third party provides assurance that the return calculations were computed fairly and accurately by the fund. It is relevant to ascertain whether most or all of the staff on the investment team that generated the past results are still currently employed by the fund. It provides some (but not absolute) assurance that similar returns may be generated in the future.

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

The New Era of Expected Credit Loss Provisioning

Topic 73

Exam Focus

This topic looks at how the accounting rules are changing to require banks and financial institutions to account for loans using expected credit losses (ECL) from the time of origination rather than waiting for specific events that suggest an ensuing high probability of losses. For the exam, understand the possible interaction between earlier provisions for loans and the impact on lending. Also, be able to compare and contrast the International Accounting Standards Board (IASB) and the U.S. Financial Accounting Standards Board (FASB).

Provision for Expected Credit Losses

LO 73.1: Describe the reasons to provision for expected credit losses.

Historical evidence suggests that loan interest rates were determined in unstable market conditions and, therefore, did not always account for all credit risks. As a result, forward-looking provisions should be made at the same time as loan origination.

The requirement for banks to set aside funds as capital reserves is unlikely to reduce a bank's lending activities during strong economic periods. The result may be excessive lending by banks. Therefore, by provisioning for **expected credit losses** (ECL), a more accurate cost of lending may be determined (which may ultimately control the amount of lending).

The concept of **procyclicality** refers to being positively correlated with the overall state of the economy. Reducing the procyclicality of bank lending is likely to occur with earlier provisioning for loan losses. Increased (decreased) regulatory requirements pertaining to provisions tend to reduce (increase) the level of bank lending.

The use of forward-looking provisions essentially results in the earlier recording of loan losses, which may be beneficial to financial statement users from the perspective of conservatism in a bank's reporting of earnings.

IASB and FASB Standards

LO 73.2: Compare and contrast the key aspects of the IASB (IFRS 9) and FASB (CECL) standards.

The IASB and FASB standards are similar in that ECL must be initially recorded at the outset of all loans and updated at the end of each reporting period, taking into account any changes in credit risks of their loan assets. In addition, the standards do not require any specific catalyst to occur in order to report a credit loss. Finally, the standards mandate the use of reliable historical, current, and forecast information (including macroeconomic factors) in computing ECL. For example, both standards measure probability of default (PD) at a point in time (rather than in context of the economic cycle) and measure loss given default (LGD) and exposure at default (EAD) as neutral estimates (rather than downturn estimates).

There are two main differences between the IASB and FASB standards:

1. FASB requires ECL to be computed over the term of a loan commencing right from the start while IASB requires a series of three stages. This difference will be discussed in more detail shortly.

2. IASB permits the recording of accrued interest income on delinquent loans, regardless of whether loan payments are being received. FASB requires the use of the cash basis (no interest income accrual), cost recovery method (payments applied to principal first, and once principal is repaid, the excess is recorded as interest income), or a combination of both in order to provide a more conservative and reliable method for income recognition on delinquent loans.

International Accounting Standards Board (IASB)

Under IFRS 9, ECL is reported in three stages to represent the deterioration of assets: *stage 1* (performing), *stage 2* (underperforming), and *stage 3* (impaired). Upon loan purchase or origination, stage 1 begins and the 12-month ECL is recorded (expense on income statement and contra-asset on balance sheet). However, interest revenue is computed on the original loan amount, not the amount net of the ECL. The 12-month ECL is computed as the expected lifetime credit loss on the loan asset multiplied by the probability of default within the upcoming 12-months after the end of the reporting date.

Stage 2 for a loan asset occurs upon severe deterioration of credit quality to require classification into a high credit risk category. That would be presumed to occur after the loan is 30 days past due according to IFRS 9. The entire lifetime ECL is now recorded (based on the present value of losses due to future defaults), which is likely a large increase in amount from stage 1. The difference in computation of 12-month and lifetime ECL can be explained primarily by the maturity of the loan together with the movement of default risks and recovery values during the term of the loan. Note that the interest revenue computation in stage 2 remains the same as in stage 1.

Stage 3 involves loan assets that are credit-impaired or generating credit losses. The entire lifetime ECL continues to be recorded but the interest revenue is now computed on the original loan amount less the loss allowance.

Financial Accounting Standards Board (FASB)

In contrast to IASB, FASB requires the entire lifetime ECL to be recorded as a provision from the outset instead of dealing with stages. As a result, the FASB standard will result in earlier and larger recognition of losses (whereas there is some delay in IASB for loans classified in stage 1). The two standards are the same when dealing with loans that have considerable credit deterioration (i.e., IASB stages 2 and 3).

Implementation of IASB and FASB Standards

LO 73.3: Assess the progress banks have made in the implementation of the standards.

The IASB standard is effective as of January 1, 2018 (although early adoption is allowed) and the FASB standard as of January 1, 2020 for public companies and January 1, 2021 for all other applicable entities.

Based on surveys conducted with banks regarding the implementation of IFRS 9, overall it appears that only minimal progress has been made as of 2016. For example, a significant number of banks were unable to quantify the impact of the new standard. For the banks that were able to make estimates, loan loss provision increases were estimated at an average of 20%, with the range typically being between 10% and 30%. A large portion of the increase is due to the recording of lifetime ECL for stage 2 loans. The amounts are not as significant for the related capital decreases [i.e., 50bp to 75bp decrease in Common Equity Tier 1 (CET1) spread and total capital ratio], but the key issue here is that the banks are generally unaware of how regulators will ultimately revise the regulatory capital amounts.

The **Enhanced Disclosure Task Force** (EDTF) has recommended specific risk disclosure by banks in the transition period prior to implementation of IFRS 9. The disclosures are qualitative (i.e., differences from current approach, implementation strategy, capital planning impact), but also include quantitative assessments of the impact of using the ECL approach. From the surveys, about 40% of the banks had no intention to make any quantitative disclosures prior to 2018.

A takeaway from the surveys is that for many banks, there are currently weaknesses in general data quality and the computation of lifetime default probabilities for loans. Improvements in the modelling processes are required as well. To date, there has been limited spending by most banks regarding IFRS 9 implementation. Specifically, many banks reported that they had insufficient technical resources to complete the implementation. Furthermore, to date there appears to have been limited involvement of key personnel such as the board of directors and senior credit risk staff.

Impact of IASB and FASB Standards

LO 73.4: Examine the impact on the financial system posed by the standards.

The impact of the IASB standard would cause a dramatic rise in loss provisions at the start of an economic downturn, specifically the increase in amounts between stage 1 (12-month ECL) and stage 2 (lifetime ECL). One argument for a more proactive stance on recording losses is that it restates the balance sheet assets at more conservative levels to make way for possible future recoveries.

In one sense, the standards would have no impact for banks that have established sufficiently large capital buffers that could withstand the impact of the increased loan provisions.

The provisioning requirements of the standards could end up smoothing the issuance of loans throughout the economic cycle (i.e., slowing the growth of loans in a strong economy while preventing the slowing of growth of loans in a weak economy). That is because the prior provisions already taken on loans should prevent the capital cost of lending from increasing when the economy weakens. In a simulation exercise involving the earlier provisioning for loans, it was found that bad debts were lower (higher) in years when loan loss provisions were high (low). With earlier provisioning taken from capital, there would be reduced levels of lending prior to an economic downturn or crisis.

Key Concepts

LO 73.1

Key reasons to provision for expected credit losses (ECL) include:

1. Determining a more accurate cost of lending.
2. Reducing the procyclicality of bank lending (by provisioning earlier for loan losses).
3. Reporting earnings in a more conservative manner, which may be useful to financial statement users.

LO 73.2

There are two main differences between the IASB and FASB standards.

1. FASB requires ECL to be computed over the term of a loan commencing right from the start while IASB requires a series of three stages.
2. IASB permits the recording of accrued interest income on delinquent loans. FASB requires the use of the cash basis and/or the cost recovery method.

LO 73.3

Based on surveys conducted with banks regarding the implementation of IFRS 9, overall it appears that only minimal progress has been made as of 2016.

For many banks, there are currently weaknesses in general data quality and the computation of lifetime default probabilities for loans. In addition, many banks reported that they had insufficient technical resources to complete the implementation.

LO 73.4

The impact of the IASB standard would cause a dramatic rise in loss provisions at the start of an economic downturn, specifically the increase in amounts between stage 1 (12-month ECL) and stage 2 (lifetime ECL).

The provisioning requirements of the standards could end up smoothing the issuance of loans throughout the economic cycle (i.e., slowing the growth of loans in a strong economy while preventing the slowing of growth of loans in a weak economy).

Concept Checkers

1. Forward-looking provisions for credit losses should be made:
   A. before loan origination.
   B. at the same time as loan origination.
   C. 3 months after loan origination.
   D. 12 months after loan origination.

2. For which measurement basis does IASB (IFRS 9) permit the recording of interest income on delinquent loans?
   A. Accrual.
   B. Cash.
   C. Cost recovery.
   D. A combination of cash and cost recovery.

3. Both the FASB and IASB standards measure loss given default (LGD) and exposure at default (EAD) as:
   A. backward-looking estimates.
   B. downturn estimates.
   C. forward-looking estimates.
   D. neutral estimates.

4. For banks that have been able to make estimates of loan loss provision increases, the percentages are, on average, closest to which of the following amounts?
   A. 5%.
   B. 20%.
   C. 35%.
   D. 50%.

5. Under the IASB standard, in which stage(s) would the impact of the provisioning rules be the greatest on a bank's income statement?
   A. Stage 1.
   B. Stage 2.
   C. Stage 3.
   D. Stages 2 and 3.

Concept Checker Answers

1. **B** The nature of forward looking provisions is that they should be made in the current period in anticipation of losses to occur in the future. Therefore, they should be made at the same time as loan origination. Provisions cannot be made before loan origination because there is no information available about the likelihood of default until the loan is actually originated.

2. **A** IASB permits the recording of accrued interest income on delinquent loans, regardless of whether loan payments are being received. FASB requires the use of the cash basis (no interest income accrual), cost recovery method (payments applied to principal first, and once principal is repaid, the excess is recorded as interest income), or a combination of both in order to provide a more conservative and reliable method for income recognition on delinquent loans.

3. **D** Both standards measure loss given default and exposure at default as neutral estimates.

4. **B** For banks that have been able to make estimates, the loan loss provision increases are an average of 20%, with the range typically being between 10% and 30%.

5. **B** There is a change from the one-year expected loss in stage 1 to a lifetime loss in stage 2, which is a very dramatic change on the income statement. There is not much of a change on the income statement between stages 2 and 3 because lifetime ECL is reported in both stages, but interest revenue is reduced in stage 3 because it is calculated only on the carrying amount less the loss allowance.

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Big Data: New Tricks for Econometrics

Topic 74

Exam Focus

This topic focuses on ways to view the explosion in data that has resulted from the growth in economic transactions that involve computers. Large amounts of data are being captured daily and this trend will only increase over time. For the exam, understand that large datasets require tools beyond ordinary least squares (OLS) regression to properly understand the inherent relationships. Machine learning offers tools like classification and regression trees, cross-validation, conditional inference trees, random forests, and penalized regression. Further opportunities exist for the field of econometrics to bring time series forecasting tools to the world of big data.

Issues Involved with Big Datasets

LO 74.1: Describe the issues unique to big datasets.

Researchers often use a spreadsheet to organize and understand datasets. However, when the spreadsheet expands to a million or more rows, a more robust and relational database is needed. Structured Query Language (SQL) databases are used for the smaller of the large datasets, but customized systems that expand upon SQL are needed for the largest pools of data. According to Sullivan (2012)[1], Google answers 100 billion search queries every month and crawls 20 billion URLs every day. This is one example of a significantly large dataset that needs customized databases to properly understand the inherent relationships involved. A system like this would be operated not on a single computer, but rather on a large cluster of computers like the type that can be rented from vendors such as Amazon, Google, and Microsoft.

Professor's Note: Using big data to make predictions is precisely what Amazon is trying to do when they make recommendations for additional purchases based on the current product search, previous purchases from the same customer, and alternative purchases made by other customers.

Another potential issue in dealing with a large dataset is known as the **overfitting problem**. This is encountered when a linear regression captures a solid relationship within the dataset, but has very poor out-of-sample predictive ability. Two common ways to address this

1. Danny Sullivan, "Google: 100 Billion Searches per Month, Search to Integrate Gmail, Launching Enhanced Search App for iOS," *Search Engine Land*, August 8, 2012, https://searchengineland.com/google-search-press-129925.

problem are to use less complex models and to break the large dataset into small samples to test and validate if overfitting exists.

In practice, researchers work with independently distributed, cross-sectional samples of a larger dataset. This enables them to focus on summarization, prediction, and estimation with a more manageable pool of information. Basic summarization often takes the form of (linear) regression analysis, while prediction seeks to use various tools to predict a value for the dependent variable, y, given a new value of the independent variable, x. This process seeks to minimize a loss function (i.e., sum of squared residuals) that is associated with new out-of-sample observations of x.

Methods are also being deployed to screen variables to find the ones that add the most value to the prediction process. Active variable selection can also help to mitigate spurious correlations and potentially help to decrease overfitting in a world where more and more data becomes available with every internet search and purchase at a retail store.

Tools and Techniques for Analyzing Big Data

LO 74.2: Explain and assess different tools and techniques for manipulating and analyzing big data.

Using big data to make predictions is the focus of **machine learning**. This science may utilize regression if a linear relationship is present. Machine learning might deploy tools, such as classification and regression trees, cross-validation, conditional inference trees, random forests, and penalized regression, if a nonlinear relationship exists.

Classification can be thought of as a binomial decision tree. For example, someone either survived the tragedy of the *Titanic* or they did not. This can be organized as a discrete variable regression where the values are either "0" or "1". This is essentially a **logit regression** and the output is shown in Figure 1.

Figure 1: Logistic Regression of Titanic Survival vs. Age[2]

Coefficients	*Estimate*	*Standard Error*	*t-Stat*	*P-value*
Intercept	0.465	0.035	13.291	0.000
Age	–0.002	0.001	–1.796	0.072

The logit regression results in Figure 1 show that age was not a significant factor in determining survival of *Titanic* passengers. Perlich, Provost, and Simonoff (2003) find that while logit regression can work very well for smaller datasets, larger pools of data require **classification and regression tree (CART) analysis.**[3] Figure 2 shows a CART for the *Titanic* using two factors: age and cabin class, and Figure 3 shows the rules used in developing this CART.

2. Hal R. Varian, "Big Data: New Tricks for Econometrics," *Journal of Economic Perspectives* 28, no. 2: 3–28, https://www.aeaweb.org/articles?id=10.1257/jep.28.2.3.
3. Claudia Perlich, Foster Provost, and Jeffrey S. Simonoff, "Tree Induction vs. Logistic Regression: A Learning-Curve Analysis," *Journal of Machine Learning Research* (June 2003): 211–255, www.jmlr.org/papers/volume4/perlich03a/perlich03a.pdf.

Figure 2: A Classification Tree for Survivors of the Titanic[4]

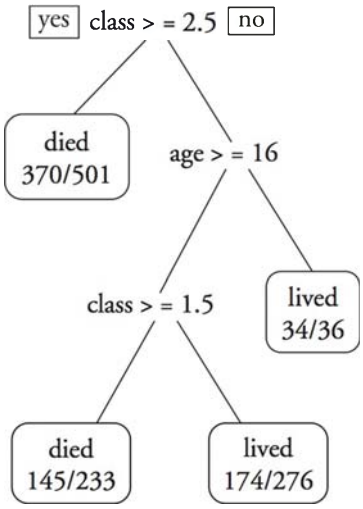


Figure 3: Titanic Tree Model in Rule Form[4]

Features	*Predicted*	*Actual/Total*
Class 3	Died	370/501
Class 1-2, younger than 16	Lived	34/36
Class 2, older than 16	Died	145/233
Class 1, older than 16	Lived	174/276

Classification and regression trees can be very useful in explaining complex and non-linear relationships. In the case of the *Titanic*, CART analysis shows that both age and cabin classification were good predictors of survival rates. This can be further dissected in Figure 4, which shows the fraction of those who survived organized into age bins.

4. Hal R. Varian, "Big Data: New Tricks for Econometrics," *Journal of Economic Perspectives* 28, no. 2: 3–28, https://www.aeaweb.org/articles?id=10.1257/jep.28.2.3.

Figure 4: Titanic Survival Rates by Age Bin[5]

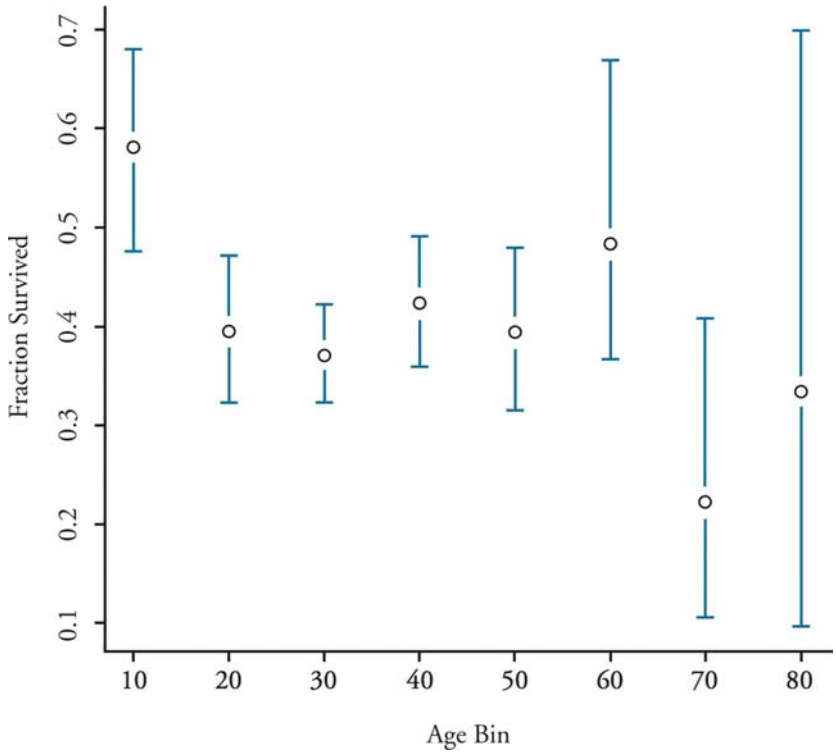


Figure 4 clearly shows that those in the lowest age bracket (children) had the highest survival rates, and that those in their 70's had the lowest. For those in between these age markers, their attained age did not really impact their survival rates. Raw age mattered less than whether a person was either a child or elderly. This process enables researchers to think dynamically about relationships in large datasets.

One concern with using this process is that trees tend to overfit the data, meaning that out-of-sample predictions are not as reliable as those that are in-sample. One potential solution for overfitting is *cross-validation*. In a ***k*-fold cross validation**, the larger dataset is broken up into "*k*" number of subsets (also called folds). A large dataset might be broken up into 10 smaller pools of data.

This process starts with fold 1 being a *testing set* and folds 2-10 being *training sets*. Researchers would look for statistical relationships in all training sets and then use fold 1 to test the output to see if it has predictive use. They would then repeat this process *k* times such that each fold takes a turn being the testing set. The results are ultimately averaged from all tests to find a common relationship. In this way, researchers can test their predictions on an out-of-sample dataset that is actually a part of the larger dataset.

Another step that could be taken is to "prune" the tree by incorporating a tuning parameter (λ) that reduces the complexity in the data and ultimately minimizes the out-of-sample

5. Hal R. Varian, "Big Data: New Tricks for Econometrics," *Journal of Economic Perspectives* 28, no. 2: 3–28, https://www.aeaweb.org/articles?id=10.1257/jep.28.2.3.

errors. However, building a **conditional inference tree** (**ctree**) is an option that does not require pruning with tuning parameters. The *ctree* process involves the following steps:

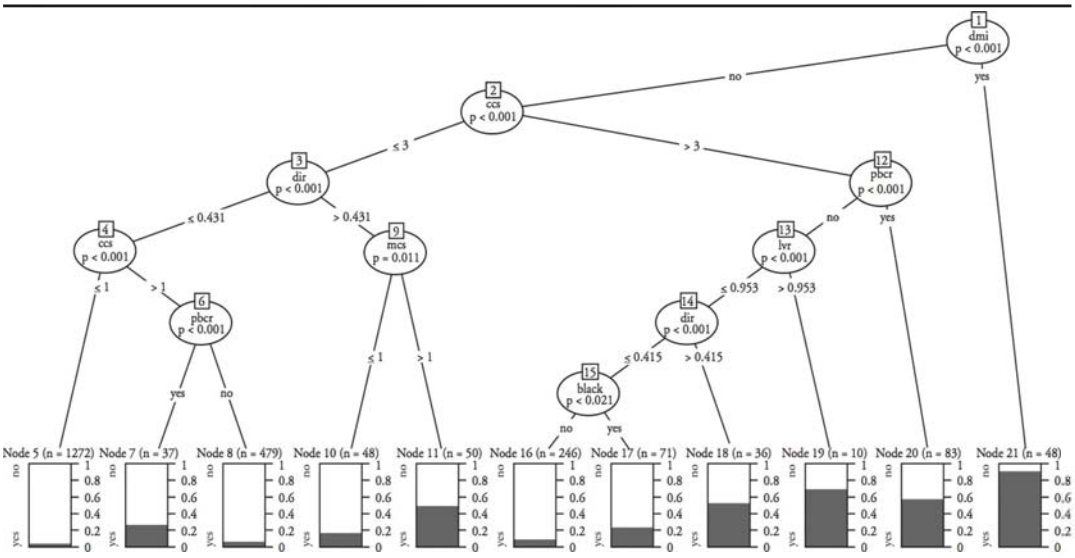
1. Test if any independent variables are correlated with the dependent (response) variable, and choose the variable with the strongest correlation.

2. Split the variable (a binary split) into two data subsets.

3. Repeat this process until you have isolated the variables into enough unique components (each one is called either a "node" or a "leaf" on the ctree) that correlations have fallen below pre-defined levels of statistical significance.

The main idea of a ctree is to isolate predictors into the most specific terms possible. Consider research conducted by Munnell, Tootell, Browne, and McEneaney (1996) that studies mortgage lending in Boston to test whether ethnicity plays a role in mortgage application success[6]. Their logistic regression finds a statistically significant relationship between being declined for a mortgage and being African American. When this data is analyzed using a ctree, as shown in Figure 5, it becomes more apparent that the true cause of mortgage application failure in this dataset is being denied mortgage insurance ("dmi" in Figure 5) not simply being African American ("black" in Figure 5). A separate test would be useful to see if being denied mortgage insurance is correlated with ethnicity.

Figure 5: Ctree for Mortgage Application Success in Boston[7]



Constructing **random forests** is also a way to improve predictions from large datasets. This method uses bootstrapping to grow multiple trees from a large dataset. Using random forests to average many small models produces very good out-of-sample fits even when dealing with nonlinear data. Computers have made this method much more viable as

6. Alicia H. Munnell et al., "Mortgage Lending in Boston: Interpreting HMDA Data," *The American Economic Review* 86, no. 1 (March 1996): 25–53, www.jstor.org.ezaccess.libraries.psu.edu/stable/pdf/2118254.pdf.
7. Hal R. Varian, "Big Data: New Tricks for Econometrics," *Journal of Economic Perspectives* 28, no. 2: 3–28, https://www.aeaweb.org/articles?id=10.1257/jep.28.2.3.

sometimes thousands of trees can be grown in a random forest. There are four steps to creating random forests:

1. Select a bootstrapped sample (with replacement) out of the full dataset and grow a tree.

2. At each node on the tree, select a random sample of predictors for decision-making. No pruning is needed in this process.

3. Repeat this process multiple times to grow a "forest" of trees.

4. Use each tree to classify a new observation and choose the ultimate classification based on a majority vote from the forest.

Researchers might also use **penalized regression**, where a penalty term (λ) is applied to adjust the regression results. Consider a multivariate regression where we predict y_t as a linear function of a constant, b_0, with P predictor variables:

$$\lambda \sum_{p=1}^{P} \left[(1-\alpha)|b_p| + \alpha |b_p|^2 \right]$$

This form of penalized regression is known as LASSO (least absolute shrinkage and selection operator) regression. The LASSO process improves upon OLS regression by using the penalty term (λ) to limit the sum of model parameters. As lambda (λ) increases, some of the regression coefficients will be driven to zero and drop out of consideration. This penalizing process enables researchers to focus on the variables that are most likely to be strong predictors. If lambda is zero, then you just have OLS regression, but as lambda increases model variance decreases.

Collaboration between Econometrics and Machine Learning

LO 74.3: Examine the areas for collaboration between econometrics and machine learning.

There are several different areas where useful collaboration could exist between econometrics and machine learning. Most machine learning assumes that data is independently and identically distributed and most datasets are cross-sectional data. In practice, time series analysis may be more useful. Econometrics can use tools like Bayesian Structural Times Series models to forecast time series data.

Perhaps the most important opportunity for collaboration relates to causal inference, which can be a natural by-product of big data. Correlation does not always indicate causation. Traditionally, machine learning has been most concerned with pure prediction, but econometricians have developed numerous tools to reveal cause and effect relationships. Combining these tools with machine learning could prove to be a very meaningful collaboration.

Consider a basic causation-correlation example. Police precincts that have a higher amount of police usually also have higher crime rates. There is a correlation, but having more police does not necessarily cause higher crime rates. A strong *historical* relationship does exist, but

it is not really useful for *predicting* the causal outcome of adding more police to a precinct. One idea to solve this problem is to use econometrics to forecast what would have happened if no additional police were added and then contrast this with what actually did happen.[8]

This same concept can be applied in many different disciplines. Consider a standard problem in marketing where a firm wants to gauge the effectiveness of an advertising campaign. They could run the new ad campaign in one region and then not run it in another region to contrast the outcomes. There are two big problems with this. First, you may have lost revenue in the control region while the test is ongoing. Second, the contrast could be from an external factor like weather or demographic differences. To avoid these problems, the firm could use econometrics to forecast the expected sales outcome in a region *without* additional advertising and then run the ads and measure the contrast between the predicted and the actual outcomes. A good model for prediction can be better than a random control group.

8. Donald B. Rubin, "Estimating Causal Effects of Treatments in Randomized and Nonrandomized Studies," *Journal of Educational Psychology*, 66, no. 5 (1974): 688.

Key Concepts

LO 74.1

Large datasets require tools that are exponentially more advanced than simple spreadsheet analysis. Overfitting and variable selection are two ongoing challenges that big data present.

LO 74.2

To solve inherent issues like spurious correlations and overfitting, researchers have applied more creative tools to analyzing large datasets. The tools include classification and regression trees, cross-validation, conditional inference trees, random forests, and penalized regression.

LO 74.3

There are several ways in which the field of econometrics can assist the world of machine learning. One way is to use time series forecasting tools that are commonly applied in econometrics to big data, which has traditionally only featured cross-sectional data. Another potential collaboration is to better understand the relationship differences between correlation and causation.

Concept Checkers

1. Which of the following statements is not a problem common to the contemporary world of big data?
   A. A researcher might find a strong in-sample prediction that does not produce good out-of-sample results.
   B. Traditional spreadsheet analysis is not robust enough to capture relationships with multiple interactions and millions of data points.
   C. Access to data is difficult.
   D. The periodic presence of spurious correlations requires active variable selection.

2. Which of the following statements is not involved in conducting a 10-fold cross validation?
   A. Test your prediction on an out-of-sample dataset to validate accuracy.
   B. Rotate which fold is the testing set.
   C. Conduct at least 10 different tests and average the testing results.
   D. Break a large dataset into 10 smaller subsets of data.

3. Which of the following statements most accurately describes the process of growing a random forest?
   A. Select a bootstrapped sample from a large dataset and grow a tree with random variables that were selected using a lambda (λ) tuning parameter. Average the results from a large number of trees that fill out the random forest.
   B. Break the full dataset into 10 identifiable subsets and build 10 different trees each having the same variables that were selected using a lambda (λ) tuning parameter.
   C. Break the full dataset into a random number of small unique datasets. Grow trees and average the results.
   D. Select a bootstrapped sample (with replacement) from a large dataset and grow a tree with random variables and no pruning. Average the results from a large number of trees that fill out the random forest.

4. Which of the following statements is least likely related to conditional inference trees (ctrees)?
   A. A ctree can help to better understand if a relationship truly exists between variables.
   B. A ctree involves creating multiple trees to test for accuracy.
   C. A ctree involves splitting variables into the smallest possible factor that can be isolated for testing.
   D. A ctree will isolate predictors into the most specific terms possible.

5. The fields of econometrics and machine learning have much that can be shared. Which of the following statements is incorrect concerning the collaboration between these two disciplines?
   A. Collaboration can be sought to better explore the blurred lines between correlation and cross-sectional prediction.
   B. More collaboration can be done to better understand time series data.
   C. Collaboration can be sought to better explore the blurred lines between correlation and causation.
   D. Combining econometric tools with machine learning could prove to be a very meaningful collaboration.

Concept Checker Answers

1. **C** Our modern world is filled with computerized commerce. This trend has created a seemingly endless stream of information that can be dissected using machine learning. Overfitting and spurious correlations are two clear issues and traditional spreadsheet analysis is simply not robust enough to capture the interactions in very large pools of data.

2. **A** Cross validation is used to conduct testing within a dataset that attempts to create virtual out-of-sample subsets that are actually still in-sample. In this example, the large dataset is broken into 10 folds and then 1 fold is selected for testing. Parameters from the other training sets are tested against the testing set and the testing set is rotated so that each fold gets a turn as the testing set. Parameters from each test are then averaged to get a population parameter used for prediction.

3. **D** Growing a random forest involves a bootstrapped sample (with replacement) from a larger data set. Researchers will then grow a tree from this sample. They will construct a large number of trees using computerized assistance and average the results to find the population parameters.

4. **B** A ctree is only one tree. A random forest is the analysis that constructs multiple trees. A ctree helps to understand relationships more deeply and it all starts with splitting variables into the smallest identifiable factor that can be isolated. The main idea of a ctree is to isolate predictors into the most specific terms possible.

5. **A** Current machine learning already has a fairly developed understanding of cross-sectional prediction. The most likely areas for collaboration with the field of econometrics include prediction with time series data and better understanding the blurred lines between correlation and causation. Combining econometric tools with machine learning could prove to be a very meaningful collaboration.

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Machine Learning: A Revolution in Risk Management and Compliance?

Topic 75

Exam Focus

Financial institutions have been increasingly looking to complement traditional and less complex regulatory systems and models with more complex models that allow them to better identify risks and risk patterns. This topic focuses on machine learning within artificial intelligence models that have been successfully used in credit risk modeling, fraud detection, and trading surveillance. For the exam, understand the various forms of models, including supervised and unsupervised machine learning, and the three broad classes of statistical problems: regression, classification, and clustering. While machine learning can provide tremendous benefits to financial institutions in combatting risks, there are considerable limitations with these highly complex models, which can be too complex to be reliably used from an audit or regulatory perspective.

The Process of Machine Learning

LO 75.1: Describe the process of machine learning and compare machine learning approaches.

Machine learning is a field of artificial intelligence (AI) that uses algorithms which allow computers to learn without programming. There are two forms of machine learning: supervised and unsupervised. In **supervised machine learning**, a statistical model is built in order to predict outcomes based on specific inputs (e.g., predicting GDP growth based on inputs of various macroeconomic variables). In **unsupervised machine learning**, data analysis is performed to identify patterns without estimating a dependent variable.

Machine learning is important because it can analyze data samples in order to identify patterns and relationships in the data, and can make out-of-sample predictions. Models are then analyzed thousands or millions of times so that the model can improve its predictive capability. In this respect, machine learning is closely tied to the "big data" revolution. Supervised machine learning can also analyze nonparametric and nonlinear relationships that can fit any given model and make inferences about the dependent and independent variables.

Machine Learning Approaches

Although many approaches exist to analyzing machine learning, it can be applied to three broad classes of statistical problems: regression, classification, and clustering. Both

regression and classification can be addressed through supervised machine learning, while clustering follows an unsupervised approach.

1. *Regression problems* make predictions on quantitative, continuous variables, including inflation and GDP growth. Regressions can involve both linear (e.g., partial least squares) and nonlinear (e.g., penalized regression in which complexity is penalized to improve predictability) learning methods.

2. *Classification problems* make predictions on discrete, dependent variables such as filtering spam email and blood types, where the variable can take on values in a class. Observations may be classified by support vector machines.

3. *Clustering* involves observing input variables without including a dependent variable. Examples include anti-money laundering (AML) analysis to detect fraud without knowing which variables are fraudulent. Data can be grouped into clusters, where outputs from unsupervised learning are used as inputs for supervised learning methods.

As mentioned, machine learning can be used to make out-of-sample predictions, for example, predicting borrowers' ability to repay their obligations and borrower default. However, a good predictive model does not need to also be good at explaining or inferring performance. For example, a credit scoring model will make inferences as to why borrowers default, whereas a good predictive model only needs to identify which indictors lead to borrower default.

Other Concepts in Machine Learning

Models that are very complex may describe noise or random error rather than true underlying relationships in the model. This is called **overfitting**. Overfitting is a particular concern in nonparametric, nonlinear models which tend to be complex by nature. Models that describe noise will only fit that specific dataset and will not perform well in out-of-sample datasets.

Boosting (or **bootstrapping**) refers to overweighting scarcer observations to train the model to detect these more easily. For example, overweighting scarcer fraudulent transactions in a dataset can train the model to better detect them. **Bagging** describes the process of running several hundreds of thousands of models on different subsets of the model to improve its predictive ability. These models may also be combined with other machine learning models, called an *ensemble*, in order to further improve their out-of-sample predictive capabilities.

Machine learning uses past, in-sample data to make predictions about future, out-of-sample data. As a result, it has been criticized at times for being backward looking and for making predictions without truly understanding the underlying relationships.

Deep Learning

Deep learning approaches move away from the "classic" model approaches we have been discussing until now. Whereas classic models focus on well-defined and structured datasets, **deep learning** essentially mimics the human brain by applying several layers of algorithms into the learning process and converts raw data to identify complex patterns. Each

algorithm focuses on a particular feature of the data (called *representations*), and the layering of these representations allows the model to incorporate a wide range of inputs, including low quality or unstructured data. Importantly, the layers are not designed by engineers, but instead learned by the model from the various data.

For example, deep learning has been used in face-recognition and natural language learning models. Models have been complex enough to be able to classify not only the discussion topics, but also the emotions of the people involved. However, deep learning models are extremely complex, often requiring several million or hundreds of millions of datasets.

The Application of Machine Learning

LO 75.2: Describe the application of machine learning approaches within the financial services sector and the types of problems to which they can be applied.

Financial institutions deal with an increasingly large volume of data they need to analyze, which requires complex analytical tools. In response to new regulations and compliance measures, following the 2007–2009 financial crisis, financial institutions have been required to report more comprehensive details on balance sheet metrics and business models. These include stress tests, and reporting on liquidity measures, capital, and collateral.

As a result, financial institutions need to be able to adequately structure, analyze, and interpret the data they collect. Various regulatory standards were introduced on data delivery with the aim to improve the quality of supervisory data, including the Basel Committee's Principles for Risk Data Aggregation (Basel 239) and IFRS 9.

Financial institutions are also faced with an exceptionally large amount of low-quality, unstructured data, called **big data**, from the output of consumer apps, social media feeds, and various systems' metadata. It has become increasingly more important that institutions are able to effectively analyze this high volume of data, including using conventional machine learning techniques as well as more complex deep learning techniques.

Financial institutions should use conventional machine learning techniques for mining high-quality, structured supervisory data. Deep learning and neural networks should be used for low-quality, high-frequency, "big data" type sources.

LO 75.3: Analyze the application of machine learning in three use cases:
- **Credit risk and revenue modeling**
- **Fraud**
- **Surveillance of conduct and market abuse in trading**

Credit Risk and Revenue Modeling

Financial institutions recently moved to incorporate machine learning methods with traditional models in order to improve their abilities to predict financial risk. In turn, they have moved away from the less complex traditional linear credit risk model regressions.

However, machine learning models are often unfit to be successfully incorporated into the ongoing risk monitoring of financial institutions. Machine learning models can be overly complex and sensitive to overfitting data. Their (often extreme) complexity makes it difficult to apply jurisdictionally consistent definitions of data, and the models are too complex for regulatory purposes, including internal models in the Basel internal ratings-based (IRB) approach, because it is very difficult for auditors to understand them.

Despite their disadvantages, machine learning models can be successfully used in optimizing existing models with regulatory functions. For example, both linear and less complex nonlinear machine learning models can be applied to existing regulatory and revenue forecasting models.

Fraud

Banks have successfully used machine learning in the detection of credit card fraud. Models are used to detect fraudulent transactions, which can then be blocked in real time. Credit card fraud can incorporate machine learning more usefully than other risk areas because of the very large number of credit card transactions that are needed for the training, backtesting, and validation of models. The models then predetermine the key features of a fraudulent transaction and are able to distinguish them from normal transactions. Models can also be successfully used in anti-money laundering or combating the financing of terrorism (AML/CFT) activities through unsupervised learning methods, such as clustering. Clustering identifies outliers that do not have strong connections with the rest of the data. In this way, financial institutions can detect anomalies and reduce the number of false positives.

Many banks still rely on traditional fraud detection through identifying individual transactions or simple patterns, but these systems lead to a large number of false positives and lack the predictive capabilities of the more sophisticated machine learning models. In addition, the traditional models still require significant human involvement to filter the false positives from suspicious activities. Data sharing, data usage, and entrenched regulatory frameworks can also hinder the successful use of machine learning.

Other factors also make the use of machine learning more difficult. Money laundering is difficult to define, and banks do not receive adequate feedback from law enforcement agencies on which transactions were truly fraudulent. As a result, it is difficult to use only historical data to teach money-laundering detection algorithms to detect fraudulent activity.

Surveillance of Conduct and Market Abuse in Trading

Surveillance of trader conduct breaches is another growing area in which machine learning is being increasingly used to detect rogue trading, insider trading, and benchmark rigging activities. Financial institutions find early detection of these violations important because they can cause material financial and reputational damage to the institution.

Early monitoring techniques tended to rely on monitoring trading behavior and assessing single trades. With machine learning, monitoring techniques were enhanced to evaluate entire trading portfolios, and connect information to other activities of the trader, including emails, calendar items, phone calls, and check-in and check-out times. The trader's behavior

could then be compared to other traders' "normal" behavior. The system detects any deviation from the normal pattern and alerts the financial institution's compliance team.

One of the challenges facing financial institutions in successfully applying machine learning includes the legal complexities of sharing past breach information with developers. Also, systems need to be auditable, but because machine learning models are designed to continuously learn from the data, it can be difficult to explain to a compliance officer why a certain behavior set off an alert. As a remedy to these problems, systems can be designed to combine machine learning with human decisions. By incorporating human decisions with machine learning, systems data can be used to know a comprehensive set of information about a trader, and create a system that is less complex and more suitable for audit and regulatory purposes.

Key Concepts

LO 75.1

Machine learning uses algorithms that allow computers to learn without programming. Supervised machine learning predicts outcomes based on specific inputs, whereas unsupervised machine learning analyzes data to identify patterns without estimating a dependent variable.

Three broad classes of statistical problems include regression, classification, and clustering. Regression problems make predictions on quantitative, continuous variables, including inflation and GDP growth. Classification problems make predictions on discrete, dependent variables. Clustering observes input variables without including a dependent variable.

Overfitting is a problem in nonparametric, nonlinear models which tend to be complex by nature. Boosting overweights less frequent observations to train the model to detect these more easily. Bagging involves running a very large number of model subsets to improve its predictive ability.

Deep learning differs from classical learning models in that it applies many layers of algorithms into the learning process to identify complex patterns.

LO 75.2

Machine learning is a powerful tool for financial institutions because it allows them to adequately structure, analyze, and interpret a very large set of data they collect, and improve the quality of their supervisory data.

Financial institutions can use both conventional machine learning techniques to analyze high-quality, structured data, and use deep learning techniques to analyze low-quality, high frequency data.

LO 75.3

Three cases of machine learning include (1) credit risk and revenue modeling, (2) fraud detection, and (3) surveillance of conduct and market abuse in trading.

Credit risk and revenue modeling, despite their disadvantages stemming from their complexity and overfitting, have been successfully used to optimize existing models with regulatory functions. These include both linear and less complex nonlinear machine learning models which can be paired with existing regulatory and revenue forecasting models.

Traditional fraud detection systems identify individual transactions or simple patterns, leading to a large number of false positives and require significant human involvement to filter the false positives from suspicious activities. Machine learning systems can help financial institutions detect fraudulent transactions and block them in real time. Clustering refers to identifying outliers that do not have strong connections with the rest of the data.

Drawbacks of machine learning include difficulty identifying money laundering, and lack of adequate feedback from law enforcement agencies.

Surveillance of trader conduct breaches through machine learning allows for monitoring techniques to evaluate entire trading portfolios, and connecting information to other activities of the trader and comparing this information to traders' "normal" behavior.

Concept Checkers

1. Which of the following classes of statistical problems typically cannot be solved through supervised machine learning?
   A. Regression problems.
   B. Penalized regression.
   C. Classification problems.
   D. Clustering.

2. Which of the following concepts best identifies the problem where a highly complex model describes random error or noise rather than true underlying relationships in the data?
   A. Bagging.
   B. Boosting.
   C. Overfitting.
   D. Deep learning.

3. Which data type is most characteristic of "big data"?
   A. High-quality data.
   B. Low frequency data.
   C. Structured supervisory data.
   D. Low-quality, unstructured data.

4. Which of the following factors does not explain why machine learning systems have been less widespread in the anti-money laundering (AML) space?
   A. Existence of unsupervised learning methods.
   B. Lack of a universal definition of money laundering.
   C. Inadequate feedback from law enforcement agencies.
   D. Inadequacy of historical data for money laundering detection algorithms.

5. A credit analyst makes the following statements:

   Statement 1: Financial institutions face barriers in applying machine learning systems because supervisory learning approaches are difficult to apply.

   Statement 2: Combining machine learning with human decisions tends to produce inferior model results.

   The analyst is accurate with respect to:
   A. statement 1 only.
   B. statement 2 only.
   C. both statements.
   D. neither statement.

Concept Checker Answers

1. **D** Clustering typically involves applying unsupervised learning to a dataset. It involves observing input variables without knowing which dependent variable corresponds to them (e.g., detecting fraud without knowing which transactions are fraudulent).

   Regression problems, including penalized regression, and classification problems involve predictions around a dependent variable. These statistical problems can be solved through machine learning.

2. **C** Overfitting is a concern where highly complex models describe noise or random error rather than true underlying relationships in the model. Overfitting is a particular concern in non-parametric, nonlinear models.

   Boosting overweights less frequent observations to train the model to detect these more easily. Bagging involves running a very large number of model subsets to improve its predictive ability. Deep learning differs from classical learning models in that it applies many layers of algorithms into the learning process to identify complex patterns.

3. **D** "Big data" is data that arises from large volumes of low-quality, high-frequency, unstructured data.

4. **A** Unsupervised learning methods can be used in AML detection to identify and learn relevant patterns in client activity.

   Money laundering is difficult to define, and financial institutions do not receive adequate feedback from law enforcement agencies on which transactions were truly fraudulent. As a result, it is difficult to use only historical data to teach money-laundering detection algorithms to detect fraudulent activity.

5. **A** Incorporating human decisions with machine learning can improve data, because systems data can be used to identify a comprehensive set of information about a trader, and create a system that is less complex and more suitable for audit and regulatory purposes.

   Financial institutions have difficulty in successfully applying machine learning because of legal complexities of sharing past breach information with developers.

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Central Clearing and Risk Transformation

Topic 76

Exam Focus

This topic emphasizes liquidity risk, as opposed to solvency risk and counterparty risk, as being the primary concern for central counterparties (CCPs) and clearing members. For the exam, focus on the advantages of central clearing as well as the sequencing involved in the five-step CCP loss waterfall, primarily the details of the third and fourth steps. A good understanding of liquidation costs is also essential.

Central Clearing of OTC Transactions

LO 76.1: Examine how the clearing of over-the-counter transactions through central counterparties has affected risks in the financial system.

Using **central counterparties** (CCPs) to clear over-the-counter (OTC) transactions has boosted the importance of CCPs in the financial system. CCPs essentially eliminate the counterparty risk inherent in bilateral transactions by making the CCP the counterparty to each side of the trade so that virtually no default risk remains.

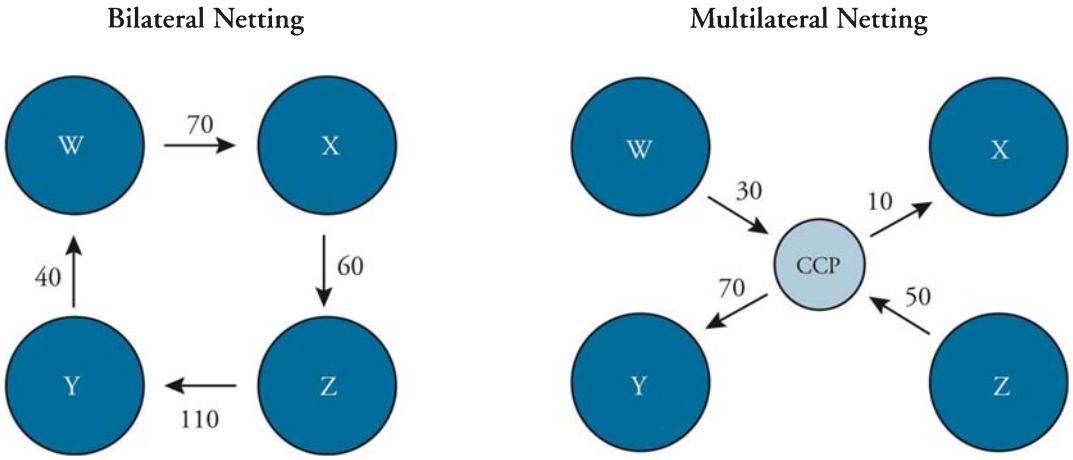
Key advantages of central clearing include:

- Halting a potential domino effect of defaults in a market downturn.
- More clarity regarding the need for collateral.
- Lower operational risk.
- Better price discovery.
- More regulatory transparency in OTC markets.
- Better risk management.

With mandatory payments of initial and variation margins, the negative impact to a defaulted counterparty is reduced or eliminated. Normally, a default by one counterparty (clearing member) means a loss for other counterparties. With the introduction of CCPs, clearing members are now exposed to the CCP and any defaults by one clearing member no longer result in a loss for the other clearing members. In case of default, assuming the CCP has the available funds, the CCP will pay the variation margins that are owed to the non-defaulting members.

Figure 1 demonstrates numerically how **multilateral netting** reduces counterparty exposures.

Figure 1: Reduction of Risk Exposure Through Multilateral Netting



Impact of Central Clearing

LO 76.2: Assess whether central clearing has enhanced financial stability and reduced systemic risk.

With central clearing, OTC exposures net of collateral between key banks have fallen to a small percentage of bank equity. The initial conclusion is that there is reduced insolvency and contagion risk, because CCPs have removed counterparty risk.

However, there needs to be a consideration of unrealized (non-cash) losses impacting solvency versus realized (cash) losses impacting liquidity. Liquid assets would consist of cash or securities that are easily converted to cash. In short, there are some situations whereby a firm may be solvent but illiquid or insolvent but liquid. A solvent (insolvent) firm simply has total asset values that are higher (lower) than total liability values. A liquid (illiquid) firm has total liquid asset values that are higher (lower) than total short-term liability values.

A firm may become insolvent due to a default by a large counterparty, whereby the decline in asset value is greater than the equity value. However, if that firm has sufficient liquid assets to cover its short-term liabilities, then the insolvency will not immediately impact the firm's ability to continue operating. In contrast, if a firm is in default on any payment required in the short-term (i.e., one day for a margin call), then there is a liquidity problem.

In practice, capital requirements to protect against declines in asset values are used to protect against insolvency. The use of short-term repurchase agreements (repos) and borrowing against the value of assets is used to protect against illiquidity. Unfortunately, it is still possible for lenders to call existing loans or abstain from future lending (resulting in a liquidity problem known as a "bank run") even if the firm has excess capital and is considered solvent.

In short, central clearing has certainly enhanced financial stability and reduced systemic risk, but it has not completely eliminated systemic risk.

Transforming Counterparty Risk to Liquidity Risk

LO 76.3: Describe the transformation of counterparty risk into liquidity risk.

In the absence of margin requirements for a bilateral OTC trade, the two counterparties would simply mark to market (MTM) their position each day. Such MTM gains/losses are unrealized in nature so they do not have any cash flow impact (i.e., no liquidity impact). However, they do impact asset values and reported income so there is an impact on solvency.

In contrast, the same trade with a CCP has three distinct cash flow impacts:

- An initial margin from each counterparty must be paid up front.
- MTM gains/losses between the CCP and clearing members must be settled on a cash basis each day or even more often (i.e., variation margin).
- Clearing members could be required to contribute to a default/guaranty fund to cover member defaults.

From an overall balance sheet and solvency perspective:

- The initial margin deposit by the clearing members to the CCP is simply that and is not a transfer of (cash) assets. The clearing member maintains the asset on its balance sheet so there is virtually no impact on solvency.
- The variation margin deposits (if applicable) would have been previously accounted for as a MTM loss. The actual cash payment to the CCP is treated similarly to the initial margin deposit in that there is no transfer of assets to the CCP. There is simply a transfer from the clearing member's liquid to non-liquid assets (i.e., classification change).
- The default fund contributions are treated similarly to the initial and variation margin defaults. However, the clearing member is subject to a 2% capital charge for the default fund contributions.

From a liquidity perspective:

- Initial and variation margins must be deposited as liquid assets (i.e., cash) so there is a noted reduction in liquidity.

In summary, the central clearing requirements do not change the clearing member's overall balance sheet value (assets or equity) so there is no solvency impact. However, there is a reclassification of assets between liquid and non-liquid so there is a liquidity impact. Therefore, the clearing member is giving up counterparty risk and accepting liquidity risk.

CCP Liquidity Resources

LO 76.4: Explain how liquidity of clearing members and liquidity resources of CCPs affect risk management and financial stability.

CCPs hold mostly liquid and low-risk assets on their balance sheets, thereby requiring very little capital to guard against insolvency risk. The corresponding liabilities are short-term and mainly represent margin balances owed to clearing members. Assuming no member defaults, CCPs receive margin and default fund contributions from members. The CCP's role is to redistribute variation margin payments from members with negative balances to

those with positive balances; the net impact to the CCP should be zero. Losses that arise due to the default of a clearing member will only impact a CCP to the extent that the CCP must make payments to the defaulted counterparties. Therefore, such cash payments represent a potential liquidity risk for CCPs, which should be its primary concern from a risk management perspective. In that regard, insolvency risk and capital sufficiency for CCPs are far less relevant.

CCP Loss Sequence

A CCP has the following liquidity resources to cover potential losses should a clearing member default (in the following sequence):

1. *Initial margin*: The initial margin paid to the CCP by each clearing member is used to cover only the direct losses incurred from the member's default.

2. *Default contribution of defaulting member*: Losses greater than the initial margin may be covered by the defaulting member's default fund contribution.

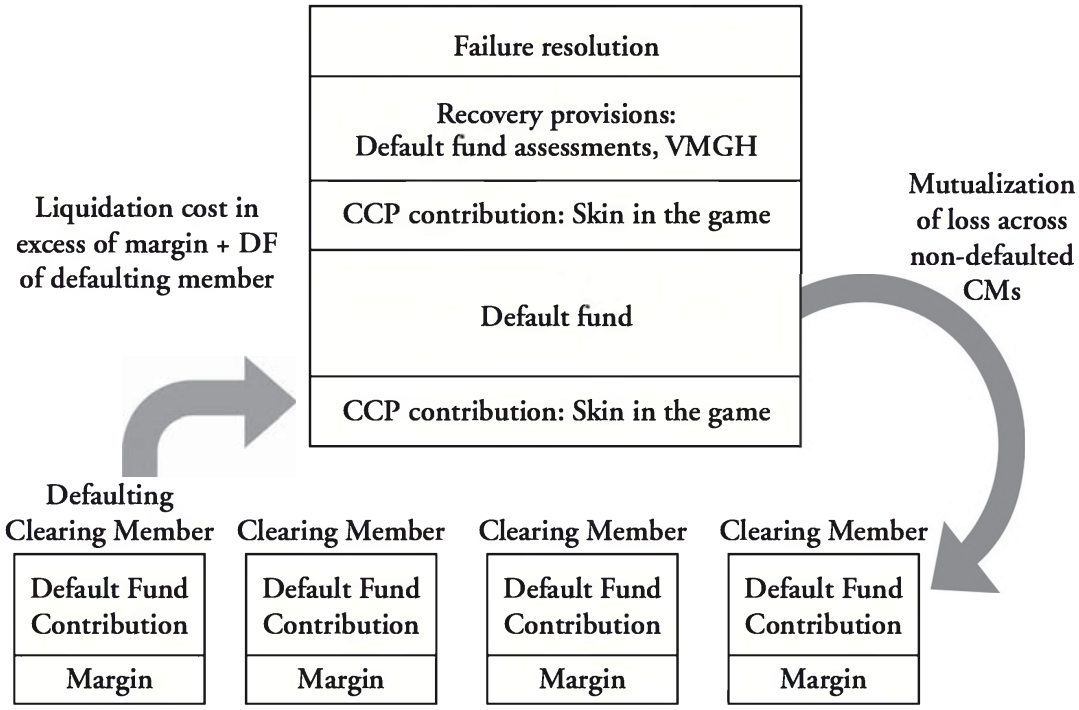
3. *Mutualization of large losses*: Losses greater than #1 and #2 combined are first covered by a maximum contribution by the CCP ("skin-in-the-game") to cover the remaining loss. If the skin-in-the-game is not enough, then the remaining losses are covered by other members' default contributions.

4. *Recovery*: Should the entire default fund be insufficient to cover the losses, the CCP could request additional default fund contributions by non-defaulting members, usually limited to the amount of the initial contribution to the default fund. Another source of funds for CCPs is variation margin haircutting (VMGH), which involves CCPs collecting variation margin payments from members with negative balances but keeping a specified percentage to boost its liquidity resources and transferring only the remaining amount to the counterparties.

5. *Failure resolution*: May occur if the CCP is unable to recover sufficient funds or if the CCP or its members do not attempt to go through the recovery provisions.

The **loss allocation process** (or **loss waterfall**) is illustrated in Figure 2.

Figure 2: Process of Loss Allocation Upon Default of a Clearing Member



Source: Chart 3: *Loss Waterfall: Allocation of Losses in the Event of a Clearing Member Default.* Reprinted from Rama Cont, "Central Clearing and Risk Transformation," Norges Bank Research, March 2017, 9.

Margin Requirements and Liquidation Costs

Initial margins cover losses as the first step of the sequence just listed. Initial margins are likely calculated based on market risk measures such as standard deviation (SD), value at risk (VaR), or expected shortfall (ES) at a 99% to 99.75% confidence level. The calculation makes use of either: (1) historical data, (2) scenario analysis, or (3) simulation using specific assumptions on relevant risk factors. The risk horizon can be described as the amount of time needed to liquidate a defaulting member's positions. That can be anywhere from one day to a few days and is computed based on the asset class being cleared, not the actual portfolio or position.

The CCP may incur a loss based on the clearing member's portfolio when the clearing member defaults. Because variation margin would have been provided prior to default, the CCP is only subject to (incremental) liquidation cost, which is the decline in portfolio value between the time of default and the time the portfolio is liquidated. Market risk measures are not effective at capturing liquidation costs because they ignore liquidity, market depth, and bid-ask spread variances between different financial instruments. Additionally, market risk is based on the net position size while liquidation costs are more related to gross notional size.

Liquidation costs can be significant for large positions or concentrated positions. A proper disposition of an unusually large position would often take additional time beyond the stated risk horizon to achieve, therefore resulting in a liquidation horizon that is greater than the risk horizon. As a result, there is a nonlinear relationship between liquidation

costs and portfolio size. A typical risk measure such as SD, VaR, or ES has a 1:1 linear relationship to portfolio notional size (N). In contrast, the relationship between liquidation cost to position size is $N \times N^{1/2}$, or $N^{3/2}$. For example, if N is doubled, SD, VAR, and ES would double as well but liquidation costs would increase by 2.83 times ($2^{3/2}$).

Proper risk management of CCPs would incorporate a liquidity charge in margin calculations to cover the implied extra costs the CCP would be responsible for when liquidating a defaulted position. The charge would increase for larger position sizes and illiquid assets (illiquid assets are being cleared more frequently nowadays). An accurate liquidity charge may encourage clearing members not to build up concentrated and/or illiquid positions so as to reduce their liquidity risk.

When determining the amount of a CCP's default fund, liquidation costs should be included. The largest clearing members provide the greatest risk to the CCP given that the former would likely engage in transactions that are more difficult to liquidate. Computing the CCP's default exposure should be more detailed and consider increased bid-ask spreads and liquidation costs. Liquidation costs are particularly relevant for large clearing members because liquidation costs are proportional to gross, not net positions.

CCP Methods for Recovering Capital

LO 76.5: Compare and assess methods a CCP can use to help recover capital when a member defaults or when a liquidity crisis occurs.

There are two methods a CCP can use to help recover capital (in the event a member defaults or a liquidity crisis occurs): default fund assessments and variation margin haircuts (VMGH).

With **default fund assessments**, the CCP could ask all non-defaulted members for a supplementary contribution that is proportional to their prior contribution and capped at that prior contribution amount. However, assuming that the largest clearing members have defaulted, there is a reasonable risk that some of the non-defaulted members have been subjected to the same losses. As a result, the non-defaulted members may have insufficient liquid resources to cover the assessment. Or if they do have sufficient resources, they may simply choose to avoid the assessment by closing out their positions or moving them to another CCP. Therefore, the shortfall in the default fund demonstrates wrong-way risk, whereby the probability of non-payment is positively related to the default events that would lead to an assessment.

A clearing member may accumulate a large amount of losses over time and ultimately default. Prior to the default, that defaulting member would have already made a corresponding large amount of variation margin payments to other members. With **variation margin haircuts** (VMGH), the CCP collects the full variation margin payment from the member with the loss, and the CCP discounts the payment (on a pro-rata basis) to the corresponding member with the gain. The difference is held by the CCP to enhance the CCP's liquidity. The liquidity is financed by the members but if clearing members are already subject to liquidity constraints in weaker market conditions, a haircut on the variation margin payment could exacerbate the liquidity constraints.

CCPs clearly benefit from having assessments and recovery options but they impose significant liquidity demands on non-defaulted members in weak market conditions. Such demands could ultimately cause those members to eventually default.

Key Concepts

LO 76.1

Key advantages of central clearing include:

- Halting a potential domino effect of defaults in a market downturn.
- More clarity regarding the need for collateral.
- Lower operational risk.
- Better price discovery.
- More regulatory transparency in OTC markets.
- Better risk management.

LO 76.2

With central clearing, OTC exposures net of collateral between key banks have fallen to a small percentage of bank equity. The initial conclusion is that there is reduced insolvency and contagion risk because CCPs have removed counterparty risk.

Central clearing has enhanced financial stability and reduced systemic risk, but it has not completely eliminated systemic risk.

LO 76.3

The central clearing requirements do not change the clearing member's overall balance sheet value (assets or equity) so there is no solvency impact. However, there is a reclassification of assets between liquid and non-liquid so there is a liquidity impact. Therefore, the clearing member is giving up counterparty risk and accepting liquidity risk.

LO 76.4

A CCP has the following liquidity resources to cover potential losses should a clearing member default (in the following sequence):

1. Initial margin.
2. Default contribution of defaulting member.
3. Mutualization of large losses.
4. Recovery.
5. Failure resolution.

LO 76.5

CCPs clearly benefit from having assessments and recovery options but they impose significant liquidity demands on non-defaulted members in weak market conditions. Such demands could ultimately cause those members to eventually default. There are two methods to consider in this situation: (1) default fund assessments and (2) variation margin haircuts (VMGH).

Concept Checkers

1. Which of the following items is not a key advantage of central clearing?
   A. Lower liquidity risk.
   B. Lower operational risk.
   C. Greater price discovery.
   D. Greater clarity with regard to the need for collateral.

2. Which of the following statements with regard to central clearing, liquidity, and solvency is correct?
   A. Central clearing has enhanced financial stability and eliminated counterparty risk.
   B. An illiquid firm has total liquid asset values that are lower than total liability values.
   C. A firm that becomes insolvent will immediately impact its ability to continue operating.
   D. The use of short-term repurchase agreements and borrowing against the value of assets is used to protect against insolvency.

3. Within a central counterparty's (CCP) role to absorb losses, which of the following risks is most relevant to the CCP?
   A. Insolvency risk.
   B. Liquidity risk.
   C. Market risk.
   D. Operational risk.

4. Which of the following items has the greatest impact on a clearing member's balance sheet?
   A. Initial margin.
   B. Variation margin.
   C. Default fund contribution.
   D. "Skin-in-the-game" contribution.

5. Initial margins requirements for clearing members are based on market risk with computations most likely at a confidence level of:
   A. 90%.
   B. 95%.
   C. 99%.
   D. 100%.

Concept Checker Answers

1. **A** Central clearing changes counterparty risk to liquidity risk, so the impact is greater liquidity risk which is a disadvantage of central clearing. The other items are all advantages of central clearing.

2. **A** Central clearing has eliminated counterparty risk; however, it has now introduced liquidity risk.

   An illiquid firm has total liquid asset values that are lower than total short-term liability values. Even if a firm is insolvent, if the firm has sufficient liquid assets to cover its short-term liabilities, then it will not immediately impact a firm's ability to continue operating. The use of short-term repurchase agreements and borrowing against the value of assets is used to protect against illiquidity.

3. **B** Losses that arise due to the default of a clearing member will only impact a CCP to the extent that the CCP must make payments to the defaulted counterparties. Therefore, such cash payments represent a potential liquidity risk for CCPs, which should be its primary concern.

   A CCP's assets are subject to market risk and insolvency risk, but because most the CCP's assets are low risk and highly liquid, both risks are of little consequence. Operational risk is present in all entities but it does not have special prominence within a CCP.

4. **C** Default fund contributions are subject to a 2% capital charge so there is an impact on the clearing member's balance sheet.

   Initial margin and variation margin have no impact on the value of the clearing member's assets since the clearing member still owns the cash collateral that is posted as margin. A "skin-in-the-game" contribution is made by the CCP, not the clearing member.

5. **C** Market risk measures such as value at risk or expected shortfall are usually computed at a confidence level between 99% and 99.75%.

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

The Bank/Capital Markets Nexus Goes Global

Topic 77

Exam Focus

In this topic, we examine the interrelationship between banks and capital markets. As the dollar replaced the volatility index (VIX) as the gauge of deleveraging in the capital markets, the role of the dollar became increasingly more important. For the exam, understand the causes of deleveraging and the role of covered interest parity (CIP) prior to the financial crisis, and why the CIP relationship failed in the post-crisis period. In addition, it is important that you understand not only why the dollar is now considered a better estimator of leverage than the VIX, but also the impacts of a strengthening dollar on banks' lending and hedging activities. A stronger dollar typically raises the cost of dollar borrowing and reduces banks' lending and hedging activities.

Banks and Capital Markets

LO 77.1: Describe the links between banks and capital markets.

Market finance has been an influential force in the financial system. Market finance can either connect borrowers and investor directly, or it can connect them through a bank intermediary in the wholesale market. A well-known example of how market finance can affect financial institutions is the case of Northern Rock. At the onset of the most recent financial crisis, Northern Rock, a British bank, collapsed in 2007 following a run on the bank by depositors. The run was preceded by a forced deleveraging by wholesale creditors in the capital markets. The key takeaway is that the link between banks and capital markets is now global.

Forced Deleveraging and Covered Interest Parity

LO 77.2: Explain the effects of forced deleveraging and the failure of covered interest rate parity.

Effects of Forced Deleveraging

Forced deleveraging refers to the reduction in leverage by a borrower following capital market events that necessitate deleveraging. A good gauge of leverage is the **haircut** in the repurchase agreement (repo) market. The haircut refers to the difference between the value of the collateral pledged and the amount borrowed. For example, a 2% haircut implies that a bank is able to borrow $98 dollars for every $100 in securities pledged. The lower

the haircut, the higher the leverage implied in the transaction. The 2% haircut implies a leverage factor (or leverage ratio) of 50 for the bank (computed as total assets over equity).

Prior to the financial crisis of 2007–2009, leverage factors of 50 were not uncommon, with corresponding very low haircut values. However, such high leverage left many banks exposed to potential forced deleveraging. Indeed, in the period immediately following the financial crisis, the leverage factor dropped to around 25 in the U.S. securities broker-dealer sector, with the haircut increasing from 2% to 4%. In general, such a large change has material consequences. Assuming a bank's equity isn't impacted, the bank would have to cut its assets in half. If the bank also suffers losses, the impact is even worse.

VIX as a Gauge of Leverage

Up until the onset of the financial crisis, the **volatility index** (VIX) represented a good gauge of the appetite for leverage in the markets. The VIX measures implied volatility from stock option (call and put) prices. Prior to the financial crisis, a low VIX implied low "fear" and therefore high leverage. The VIX was able to adequately capture the risk appetite within the financial system. Given that banks typically borrow in order to lend funds, easy conditions for borrowing also created easy conditions for lending, creating a circular series of events that led to ever easier borrowing and liquidity as well as higher leverage.

However, the VIX as a reliable gauge of leverage shifted dramatically following the financial crisis. The previous relationships of high VIX-low leverage / low VIX-high leverage ceased to hold and the VIX lost its explanatory power of leverage. While there remains considerable risk appetite for stocks, as witnessed by high stock valuations and low volatility, the banking sector has not fared comparatively well, with low market-to-book value ratios.

So what has changed? One explanation is that monetary easing has calmed markets and compressed credit spreads, although this explanation generally holds best when policy rates are positive. Another explanation could be the role of regulation, which impacts bank behavior and may constrain leverage. A counterargument to the role of regulation is that the financial crisis was not brought on by regulatory change (although regulatory change certainly followed in the post-crisis period). Capitalization also plays a role in the financial health of the banking sector. Better capitalized banks weathered the crisis better and have fared well compared to their weaker capitalized counterparts.

Failure of Covered Interest Arbitrage

Covered interest parity (CIP) is a parity condition that states that the interest rates implied in foreign exchange markets should be consistent with the money market rate for each currency. In other words, the interest rate implied between the forward and spot rates on a U.S. dollar forward or swap (one side borrows U.S. dollars and lends another currency) should be the same as the money market interest on the dollar. If the relationship does not hold, an arbitrage opportunity would exist for earning a profit on borrowing cheap in one currency, lending out funds at a higher rate in another currency, and concurrently fully hedging currency risk.

CIP held up reasonably well before the financial crisis. However, the relationship no longer worked well in the post-crisis period, and a gap between CIP-implied rates and observed

rates has persisted. The primary reason for the difference is that CIP is a theoretical concept based on certain simplifying assumptions, including the ability to take on any position in any currency at prevailing market prices. In reality, borrowers and lenders need to transact through banks, which may not have sufficient capital to enter into these transactions or may find the spreads to be uneconomical. Capital may be insufficient partly due to regulation, although banks typically have capital well above regulatory requirements.

U.S. Dollar as a Gauge of Leverage

LO 77.3: Discuss the US dollar's role as the measure of the appetite for leverage.

We already noted that the VIX is no longer a reliable gauge of leverage. In recent years, the U.S. dollar emerged as a viable alternative to the VIX. During periods with a weak dollar, risk appetite tends to be strong. With a strong dollar, risk appetite is weak and market anomalies like the breakdown of CIP occur more frequently. This inverse relationship is readily apparent when comparing the value of the dollar (or of the dollar/euro exchange rate) against the cross-currency basis of a basket of advanced economy currencies over the last few years. As the dollar appreciated, the cross-currency basis widened. The relationship is particularly true since 2014, which marked the beginning of a strong dollar appreciation. The wider basis can be seen as an incremental cost of borrowing in dollars (i.e., wider basis, higher cost).

Any deviation from CIP can be interpreted as the price that banks place on leverage. Any gap between the CIP implied rate and actual rate would represent a profit potential for the banks, borrowing at a low rate and lending at a higher rate, while fully hedging currency risk. The fluctuation in the cross-currency basis in effect implies an opportunity cost ("money left on the table") for banks and could be seen as a pressure of forced deleveraging.

What is clear is that following the financial crisis, the dollar has replaced the VIX as the reliable measure of the price of bank balance sheet and leverage. The dollar now functions as a risk factor that effectively prices the CIP deviation.

Why is the Dollar a Good Measure of Leverage?

In recent years, interest rates have fallen considerably around many parts of the world. U.S. assets, however, have remained above many advanced economy asset returns. As a result, investors have increased their demand for higher yielding assets denominated in U.S. dollars. However, this creates a currency mismatch and risk for institutional investors who hold dollar investments but have commitments to domestic stakeholders. For example, a German life insurance company has domestic currency (euro) obligations to its policyholders and beneficiaries. If the life insurance company has an investment portfolio denominated in dollars, it is exposed to volatility in the value of the dollar, and will therefore hedge any dollar currency risk. Hedging is typically done through a local bank that provides hedging services. The bank will also want to hedge its own currency risk by borrowing in dollars. As a result, the global dollar intermediation will mirror currency hedging demands.

The Impact of Dollar Strengthening

LO 77.4: Describe the implications of a stronger US dollar on financial stability and the real economy.

While the impact of a stronger dollar has been extensively discussed, the impact on the balance sheet of financial institutions is less well known. With a change in the dollar, both an institution's asset and liability values will change. A weaker dollar will benefit liabilities (make them smaller), while a stronger dollar will negatively impact liabilities (make them larger). To take the simple example of an emerging market company with dollar liabilities but domestic currency assets (we call this a naked currency mismatch), a weaker dollar will erode the value of the liabilities, thereby positively impacting the balance sheet position of the entity, reducing tail risk. This would allow the entity to borrow more in capital markets. Conversely, a stronger dollar increases the value of liabilities, thereby increasing tail risk and negatively impacting the balance sheet and credit borrowing capacity. As a result, a dollar appreciation is often accompanied by a decline in global dollar lending activities.

For global banks that provide both dollar lending (which requires them to borrow dollars) as well as domestic hedging services, an increase in risk on the lending side will reduce their capacity to provide hedging services to domestic institutional clients.

It is important to recognize that the strengthening and weakening of the dollar has opposite impacts in the export and lending markets. A foreign currency appreciation (domestic currency depreciation) is positive for economic activity in the export market, but is negative in the borrowing market as it erodes the strength of the balance sheet.

International Dollar Lending

The dollar lending in international markets reflects changes in the size of balance sheets and is a good proxy for risk appetite and leverage. In response to a dollar appreciation, bank lending in dollars will decline, reducing banks' hedging activities to institutional players. This creates a demand-supply imbalance and raises the cost of hedging, and will also result in wider divergences from CIP.

When calculating the dollar credit by banks to an international borrower, it is important to look at bank lenders in all international markets, not just U.S. lenders. For example, European banks have historically been one of the largest dollar lenders to Asian borrowers and have played an important role in dollar intermediation. As a result, when assessing the total dollar credit to Asian borrowers, it is important to look at not only U.S. lenders but also European and other international lenders.

Volatility and changes in the dollar have important implications for the stability of financial markets and for the real economy. As banks reduce their intermediation activities in response to rising volatility, they would inadvertently magnify shocks, rather than absorb them. Furthermore, because the dollar now reflects global risk appetite, a strengthening dollar truly has global implications.

Key Concepts

LO 77.1

A key takeaway in the post financial crisis period is that the link between banks and capital markets is now global.

LO 77.2

External market factors and wholesale creditor sentiment can cause forced deleveraging.

The VIX, which measures implied volatility and is a "fear gauge," was a reliable measure of leverage prior to the financial crisis. High VIX implied low leverage, and low VIX implied high leverage.

In the post-crisis period, the VIX lost its predictive ability. Attempted explanations of this change include monetary easing, regulations, and higher bank capitalizations.

Covered interest parity (CIP) is a parity condition that states that the interest rates implied in foreign exchange markets should be consistent with the money market rate for each currency. If CIP does not hold an arbitrage opportunity exists. CIP held up well before the financial crisis but it has not worked well in the post-crisis period, creating a persistent gap between CIP-implied rates and observed rates.

LO 77.3

In the post-crisis years, the U.S. dollar replaced the VIX as a more reliable measure of leverage. During periods of a strong dollar, risk appetite is weak. A period of a strong dollar also implies a wider cross-currency basis, raising the incremental cost of borrowing in dollars. The dollar also effectively prices the CIP deviation.

The fluctuation in the cross-currency basis implies an opportunity cost and could be seen as a pressure of forced deleveraging.

The higher return in recent years of dollar assets increased the demand for dollars. To hedge the volatility of the dollar, international investors hedge any dollar currency risk through banks, which in turn hedge their own risk by borrowing in dollars. The global dollar intermediation will mirror currency hedging demands.

LO 77.4

Changes in the value of the dollar will affect an institution's asset and liability values. A stronger dollar will increase dollar liabilities, thereby increasing tail risk and negatively impacting an institution's balance sheet and credit borrowing capacity. A dollar appreciation is often accompanied by a decline in global dollar lending activities.

In response to a dollar appreciation, banks' dollar lending will fall, reducing their hedging activities. This creates a demand-supply imbalance and raises the cost of hedging.

Given the size of dollar lending by non-U.S. entities, it is important to factor in the dollar lending of all international lenders when calculating the dollar credit by banks to international borrowers.

As banks reduce their intermediation activities in response to rising volatility, they may inadvertently magnify shocks.

Concept Checkers

1. A rise in the haircut from 3% to 5% for a security under a repo transaction implies that:
   A. leverage increased by 2%.
   B. leverage increased to 20 times.
   C. leverage decreased by 2%.
   D. leverage decreased to 20 times.

2. Which of the following factors would most likely be associated with a low volatility index (VIX)?
   A. Low volatility, high leverage.
   B. Lack of borrowing activity.
   C. High volatility, low leverage.
   D. Low lending by global banks.

3. Which of the following statements regarding covered interest parity (CIP) is not correct?
   A. If CIP does not hold, market participants could make arbitrage profits.
   B. The principle of CIP holds that interest rates implied in foreign exchange markets should be consistent with spot short-term interest rates.
   C. For currencies A (domestic) and B (foreign), CIP requires only the spot and forward exchange rates for A and B and the money market interest rate on A.
   D. CIP states that the forward and spot exchange differential on two currencies should mimic the ratio of money market interest rates on these currencies.

4. Which of the following borrowers would likely benefit the most by a weaker dollar?
   A. Borrowers with dollar assets exceeding dollar liabilities.
   B. Borrowers with dollar liabilities exceeding dollar assets
   C. Borrowers with domestic (non-dollar) assets and dollar liabilities.
   D. Borrowers with dollar assets and domestic (non-dollar) liabilities.

5. Which of the following factors is most associated with a stronger dollar?
   A. Stronger balance sheet of dollar borrowers.
   B. Reduced tail risk in the borrower's credit portfolio.
   C. Less capacity for credit extension.
   D. Increased lending by creditors.

Concept Checker Answers

1. **D** A rise in the haircut from 3% to 5% implies that entities can only borrow 95 cents on the dollar, rather than the previous 97 cents. This implies a decline in leverage. Thus, the leverage factor declined from 33 times to 20 times.

2. **A** Because the VIX is a measure of implied volatility, a low VIX value implies low market volatility. When volatility is low, leverage tends to high, with a large number of borrowers and lenders transacting in the market.

3. **C** For currencies A and B, CIP uses the spot and forward exchange rates for A and B and the money market interest rate on both A and B (not just on A).

   The other statements are all correct. If CIP holds, there are no arbitrage opportunities. If CIP doesn't hold, a market participant could make an arbitrage profit by borrowing money at the lower interest rate, lending money at the higher interest rate, and concurrently fully hedging currency risk.

4. **C** A weaker dollar lowers the value of both dollar liabilities and dollar assets. An entity with domestic (non-dollar) assets and dollar liabilities will benefit most, since the asset value would remain unaffected by the dollar weakening, but the liability value would fall. As a result, the entity's equity would increase.

5. **C** A stronger dollar increases the dollar liabilities of borrowers, which weakens their balance sheet. As their balance sheet weakens, their demand for additional borrowing declines, reducing dollar lending activities in the market.

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

FinTech Credit: Market Structure, Business Models and Financial Stability Implications

Topic 78

Exam Focus

FinTech can be defined as technologically enabled financial innovation that could result in new business models, applications, processes or products with an associated material effect on financial markets, financial institutions, and the provision of financial services.[1] This purely qualitative topic begins by providing details as to how FinTech credit markets could develop as well as possible impediments. For the exam, focus on the mechanics of the traditional P2P lending model and be able to compare and contrast it with other models. A thorough knowledge of both the micro and macro benefits and risks of FinTech credit markets is key to this topic.

FinTech Credit Markets

LO 78.1: Describe how FinTech credit markets are likely to develop and how they will affect the nature of credit provision and the traditional banking sector.

At present, FinTech credit markets are relatively insignificant compared to conventional markets although FinTech has been developing at a rapid speed in the past few years. In this section, we will examine reasons supporting development (subdivided between supply and demand issues) and potential challenges to development.

Development Due to Supply Reasons (Platforms)

FinTech lenders are likely to go further beyond conventional lenders in their use of technology, specifically digital innovations. Greater automation in the loan granting process as well as the use of non-traditional (but relevant) data may lead to more timely credit decisions, thereby resulting in stronger client service.

The use of an online business model for FinTech platforms typically has small upfront costs and may also result in a high level of standardization (i.e., digital contracts not requiring in-person meetings) that would lead to significant cost savings. Of course, there may be limits to the amount of standardization in a given geographical location due to its corresponding legal constraints and segmentation of credit markets.

1. Mark Carney, "The Promise of FinTech—Something New Under the Sun?" (speech at the Deutsche Bundesbank G20 Conference on Digitizing Finance, Financial Inclusion and Financial Literacy, Wiesbaden, Germany, January 25, 2017).

FinTech lenders may be able to operate in the same way as conventional lenders, yet avoid their large fixed costs (i.e., branch banking system, significant IT infrastructure) as well as regulatory constraints (i.e., capital and liquidity requirements).

Finally, conventional lenders have left some business opportunities open to FinTech lenders, including a reduction or discontinuance in lending in specific markets after the most recent financial crisis (or they have not fully exhausted the lending potential in particular markets). It is possible that tax and regulatory incentives pertaining to untapped markets will open the door to FinTech lenders. Additionally, some of those markets may generate excess profits to lenders for which FinTech lenders would like to earn.

Development Due to Demand Reasons (Borrowers or Lenders)

The fact that many customers are now extremely internet savvy and appreciate the ease and timeliness of online banking is a strong argument for the further development of FinTech credit markets. With many younger customers (e.g., age 35 and under) who have always lived in the digital age, there is a huge opportunity for online lending and borrowing. Additionally, with certain emerging markets that are finally entering the digital age, it opens up further opportunities for FinTech credit.

FinTech has a possible opening in the market resulting from the loss of trust in traditional lenders in the aftermath of their failures to provide credit to borrowers during the financial crisis. Also, a sense of social value-added [i.e., peer-to-peer (P2P) lending] may be associated with FinTech lending compared to the profit objective of traditional lending.

FinTech loans may be appealing to investors who view FinTech lending as investing in an alternative asset class that may provide higher returns and lower risk, the latter of which is achieved through a more diversified investment portfolio.

With the greater desire of lenders to lend online, it may eventually lead to borrowers following suit to borrow online given the increased availability in the marketplace.

Possible Impediments to Development

Traditional banks have been in the online banking world for many years and some customers are satisfied with their existing digital banking services and may not be willing to switch to an "unknown" digital lender.

Growth may be impeded during an economic downturn. To date, many FinTech lenders have not operated through an entire credit cycle of an upturn and a downturn. Therefore, considerable uncertainty exists as to whether emerging FinTech lenders would survive the downturn.

Regulatory requirements may vary widely depending on location and could severely limit the growth of FinTech in jurisdictions where the licensing requirements are overly onerous or where interest rate limits apply. With the ongoing development of FinTech, the related regulations will change and create significant uncertainty for borrowers (i.e., consumer protection) who may feel nervous about online borrowing as a result.

There is also the generic concept of reputational risk should some FinTech lenders operate in an unscrupulous manner during a sensitive industry development phase when FinTech lenders are trying to create their presence as an alternative source of funds in the marketplace.

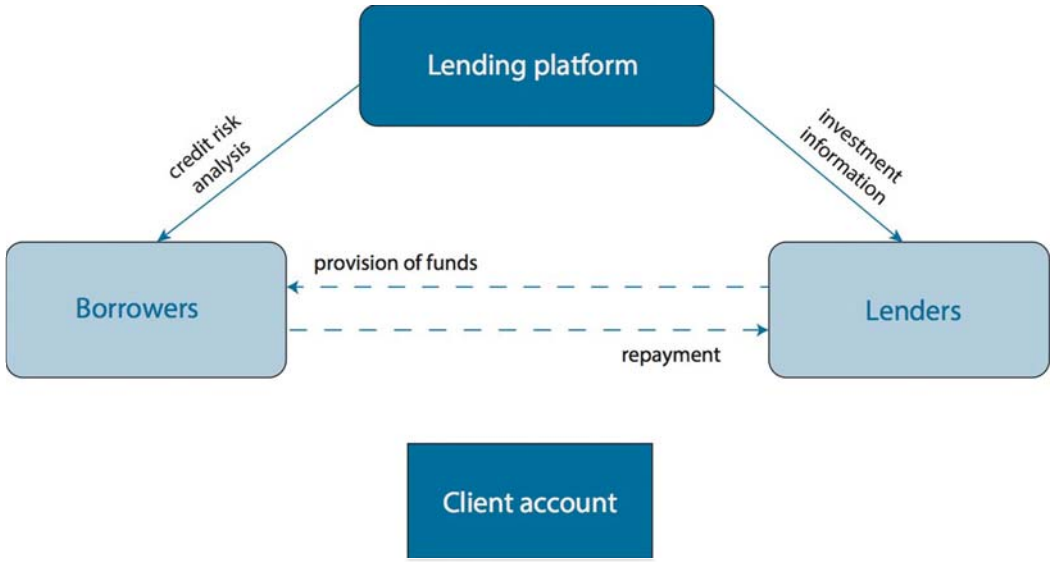
FinTech Credit Platforms

LO 78.2: Analyze the functioning of FinTech credit markets and activities, and assess the potential microfinancial benefits and risks of these activities.

Traditional P2P Lending Model

P2P lending platforms establish an online presence whereby borrowers and lenders may interact directly with each other as shown in Figure 1.

Figure 1: Traditional P2P Lending Model



Source: Graph 2: *Stylized Traditional P2P Lending Model*. Reprinted from "FinTech Credit: Market Structure, Business Models and Financial Stability Implications," BIS—Committee on Global Financial Systems, May 2017, 11.

The potential borrower makes an initial loan application on the online platform by providing the required information, which is reviewed and approved by the platform. From there, only the approved applications will go into the pool from which potential lenders may select the loan(s) they want. At that point, the loan contracts are established directly between the borrower and lender. From the borrower and/or lender, the platform operator takes fees such as for loan setup or loan repayments.

Loan selection occurs using criteria such as loan purpose, borrower industry, and borrower income. Loans will be established if they fall within the acceptable time period stated by the borrower.

The platforms provide an overall credit rating or score that could be determined internally or obtained from a third-party. For an internal assessment, the process is proprietary but likely considers newer and less common kinds of data (i.e., online spending habits) together with more sophisticated methods of analysis.

Lenders are usually advised by platforms to lend to more than one borrower to adequately diversify their investment. In certain instances, there may be an automatic selection process for the loans based on predetermined criteria set by the lender, such as loan amount or credit score. If enough loans are selected by one lender, the result is a pooling of loans similar to a securitization scheme.

There are three basic methods in establishing loan interest rates—in general, borrowers establish the maximum rate and lenders establish the minimum rate. The platform operator uses the information together with the loan amounts to match borrowers and lenders.

- Potential lenders make interest rate bids on loans within a range (i.e., minimum stated by platform operator based on risk assessment and maximum stated by borrower).
- The platforms provide the rate consistent with the credit risk assessment for the loan (that may be flexible depending on supply and demand).
- Borrowers are given a representative rate for an online loan based on a risk assessment and can seek out appropriate lending alternatives based on the rate.

The majority of platforms allow for partial or full prepayment of loans on a penalty-free basis. On the assumption that payments are made as scheduled, there is no further monitoring of the loan and the borrowers could use the funds for any purpose.

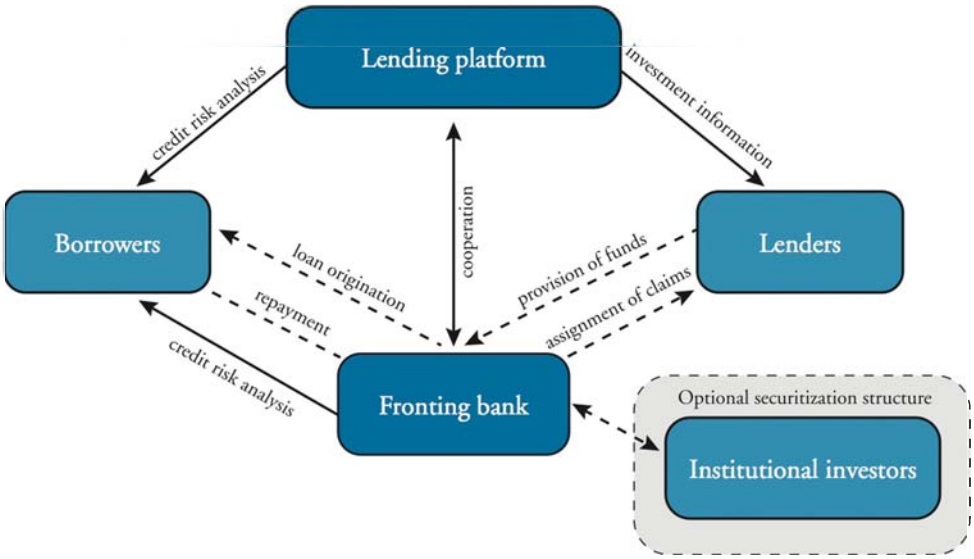
In contrast, should a borrower be potentially delinquent on a loan, they should contact the platform as soon as possible to avoid the platforms contacting debt collection agencies to begin the loan recovery process. At the point of delinquency, the platform may start charging additional fees to the lender. Some platforms have methods to deal with credit losses, which could be in the form of insurance or guarantee/provision funds that provide partial or full coverage of the loan portfolio (i.e., there could be exclusions for higher credit risks). As for the percentage of loss covered, there is a wide range from 2.5% to 70% of the principal amount. An alternative method has the objective to pay out, at a minimum, the expected lifetime default rate for covered loans.

Should lenders wish to exit their loan investments, some jurisdictions allow those creditors to do so by paying fees to the platform and on the condition that other lenders will take over those loans. There also may be no exit guarantee if there are an excessive number of exit requests on the platform at the same time.

Notary Model

The notary model is used frequently in Germany, Korea, and the United States. There is a partnership agreement between a fronting bank and the lending platform because the fronting bank actually originates the loans. The loans are then sold or assigned by the fronting bank directly to interested lenders or through a platform subsidiary (securitization) to institutional investors. The following diagram presents the basic model; some differences exist in its application in some jurisdictions.

Figure 2: Notary Model



Source: Graph 3: *Stylized Notary Model*. Reprinted from "FinTech Credit: Market Structure, Business Models and Financial Stability Implications," BIS—Committee on Global Financial Systems, May 2017, 13.

This is the approach used in Germany because only authorized institutions (i.e., not lending platforms) are permitted to provide loans.

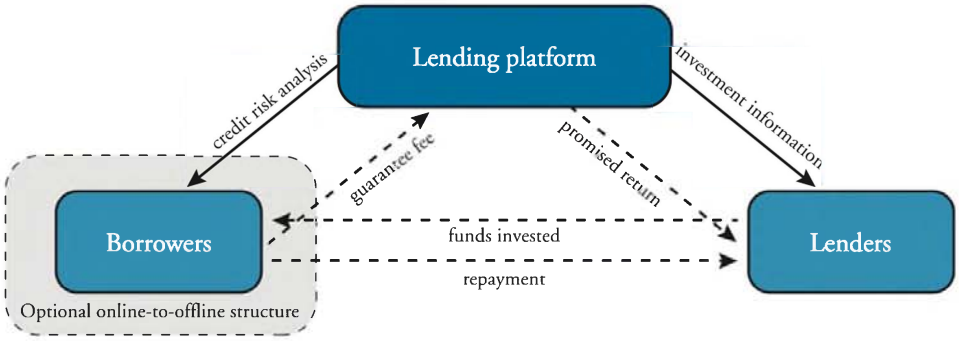
In Korea, there is no lending by the lending platform and it is all done by a separate subsidiary that sets up the loans using the funds provided by lenders to the lending platform. Alternatively, a fronting bank is used to set up the loans; the platform transfers the funds to the bank in the form of collateral.

In the United States, regulatory restrictions sometimes cause FinTech lenders to work with a lending institution. The lending institution issues the loans to borrowers from the lending platform. The lending institution may either retain the loans or hold them for a very short period of time and then sell them to the platform lender. The platform lender may then either hold the loans or sell them directly to investors.

Guaranteed Return Model

With the guaranteed return model, the lending platform guarantees the principal and/or interest on the loans.

Figure 3: Guaranteed Return Model



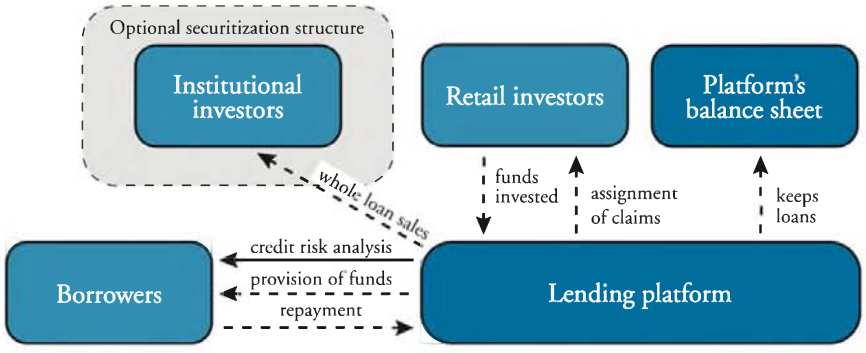
Source: Graph 4: *Stylized Guaranteed Return Model.* Reprinted from "FinTech Credit: Market Structure, Business Models and Financial Stability Implications," BIS—Committee on Global Financial Systems, May 2017, 14.

Historically, this model has been used notably in China and Sweden. In China, some platforms guaranteed the principal amounts on the condition that the lenders held an extremely diversified loan portfolio. Another platform simply provided a 12% return on investment. However, recent regulatory changes now prohibit online lenders from offering such guarantees. In Sweden, a 12% return was guaranteed by one online platform to investors together with very few access restrictions; ultimately, the platform was forced by regulators to cease operations due to findings of misconduct.

Balance Sheet Model

The balance sheet model involves the lending platform operating much the same way as a non-bank lender; it requires capital (i.e., debt, equity, securitization) to originate loans but it also retains the loan receivables as assets.

Figure 4: Balance Sheet Model



Source: Graph 5: *Stylized Balance Sheet FinTech Lending Model.* Reprinted from "FinTech Credit: Market Structure, Business Models and Financial Stability Implications," BIS—Committee on Global Financial Systems, May 2017, 15.

This model is used extensively in Australia, Canada, and the United States with the United States being the largest in absolute dollars. In China and the United States, some platforms operate as a combination of the traditional P2P and the balance sheet models, or they combine P2P lending platforms with businesses such as wealth management, trading, and insurance.

Invoice Trading Model

Firms often make credit sales and record corresponding receivables (or invoices) on their balance sheets. However, for quicker conversion of those receivables to cash, they will often sell (factor) them at a discount. If the receivables are sold on a non-recourse basis, the discount is larger and the credit risk of the receivables is transferred to the purchaser. On a recourse basis, the discount is smaller and the credit risk of the receivables remains with the seller. Given that non-recourse factoring is riskier, there may be a minimum amount of business activity required. Therefore, recourse factoring seems to be the most common form for start-ups or small businesses.

Invoice trading platforms providing recourse factoring have become popular because they include perks such as automatic invoice processing, less delay between invoice processing and cash payment, and a lower level of business activity required.

Lenders

P2P lending platforms originally began with individuals lending directly to borrowers. There has been an evolution in P2P lending such that institutional investors are funding a substantial portion of personal and business loans, especially in the United States and Canada. In contrast, much of the funding in Europe, the United Kingdom, and Japan is private.

Within institutional funding, securitizations have occurred almost exclusively in the United States with only a small number in the United Kingdom and Australia.

The majority of platform creditor funds are sourced domestically, especially in the Americas and Europe. Cross-border funding at about one-third of the total amount is highest in the Asia-Pacific region (outside China). Individual (non-professional) investors are usually limited to investing amounts ranging from $2,000 to $18,000, depending on the jurisdiction (amounts are generally higher in China and lower in Europe). There are no investment limits for professional or institutional investors.

Borrowers

The two main types of credit are individual loans and business loans, with debt refinancing and consolidation being the most common reasons for individual loans. The typical borrower sought by platforms is a low credit risk. Average individual loan sizes vary from $5,000 to $25,000. In the United States, the average is closer to $25,000 and in China, the average is in excess of $50,000.

Platforms provide business loans to small and medium-sized businesses on both a secured and unsecured basis. It is estimated that about two thirds of business lending is secured, most commonly with real estate. Business lending in the Americas and Europe is primarily domestic while in the Asia-Pacific region, more of it is international.

Microfinancial Benefits

Lower Financing Costs for Borrowers

With FinTech's lower costs through the extensive use of computerization and automation (i.e., loan approval, loan pricing) and the absence of physical "bricks and mortar" operations, the cost savings should theoretically flow through to borrowers in the form of lower interest rates.

Some studies have shown that overall, smaller loans to individuals are priced lower than traditional banks. Other studies have shown very close rates once adjustments for risk are considered. And other studies have shown marginally increased rates for mortgages (secured with real estate) once adjustments for differences in property location and loan attributes are considered.

Loans in certain lending platforms have a very wide dispersion of rates (i.e., 6% to 36% per annum) compared to regular banks, which suggests that lending platforms may be dealing with a more diverse group of borrowers and/or the existence of greater precision in loan pricing using specific risk factors.

Higher Returns for Lenders

Following the same logic for passing on cost savings to borrowers, the effect on lenders would be in the form of higher returns. However, quantifying the benefit is problematic because of the difficulty in finding comparable investments with the same risk features (i.e., duration and liquidity) as FinTech loans.

One study concludes on an average return of 7%, which is 3% higher than the return on a somewhat comparable index of asset-backed securities. A different survey suggests returns between 5% and 10%. Data from one platform shows rates of return ranging from 8% (lowest default probability) to 24% (highest default probability).

User Convenience

With substantial full use of a computerized environment for providing loan information and assessing loan risk, the search costs for borrowers and lenders is significantly reduced. With a very streamlined and easy process, lenders may be able to offer loans to borrowers at an amazing speed (i.e., minutes or hours). That is in direct contrast to traditional banks that typically operate in a less computerized environment with manual processes that ultimately delay the loan approval process.

Accessibility

FinTech could assist existing borrowers by offering additional types of financing when needed. Invoice trading platforms, for example, could be used by small borrowers to access cash quickly instead of paying overdraft interest at a high rate. In that regard, some jurisdictions actively support such lending to promote economic growth. The support is shown through tax benefits provided to FinTech investors.

Some groups of (potential) borrowers, such as self-employed individuals and small business owners, have historically been unable to qualify for loans from traditional banks. With the introduction for FinTech lending, such "forgotten" borrowers can finally obtain the small-dollar loans that they require to grow their businesses.

Within emerging market economies, surveys indicate that many individuals have never borrowed from a traditional bank. With the user-friendliness of many lending platforms, FinTech is likely to increase accessibility to credit for a substantial number of users who otherwise would not have access.

Microfinancial Risks

Leverage and Liquidity Risk

The majority of lending platforms function as agents to bring investors together with borrowers. Therefore, such platforms have little or no leverage risk. A few platforms take on leverage risk in that they use internal resources to fund loans or provide return guarantees.

Most lending platforms also take on little or no liquidity risk (investment and loan durations are usually the same and investors must maintain their loan investments until they mature). At the same time, some platforms are now providing investors with the ability to withdraw amounts early. One example of such a platform allows investors to invest in loans and withdraw amounts at any time and at no charge. Although it is explicitly stated that there is no absolute certainty that the withdrawals will be granted, there is the risk that investors may expect liquidity regardless.

Operational Risk

FinTech platforms face cyber risks given their extensive use of electronic data. Such risks are likely to increase with the level of platform sophistication and will decrease with the strength of their procedures in managing confidential client data and strength of their cybersecurity procedures. With regard to data storage, for example, it requires the platforms to outsource that task to an external provider so there is operational risk should there ever be service disruption. Fraud risk exists because the nature of FinTech lending makes money laundering and other forms of misconduct (i.e., Ponzi schemes) a distinct possibility.

Credit Risk Assessment Quality

FinTech platforms make use of big data analytics, which includes some more unusual but relevant data, to supposedly improve credit risk assessment over that of traditional banks. By taking a more focused analytical process and avoiding the pitfalls of outdated IT systems, the credit assessment may be enhanced. To date, it is not possible to conclude with certainty that FinTech platforms have superior credit risk assessment processes.

Three key arguments against higher quality credit risk assessment of FinTech platforms include: (1) platforms likely do not have detailed borrower information such as income, assets, and liabilities, (2) some platforms use solely hard data sources and do not consider soft credit risk factors, and (3) loan default data for unchartered borrower segments may be unreliable or unavailable.

Business Model Incentives

The use of the agency model where lenders generate fees from creating new loans, but do not bear any credit risks, may promote the wrong incentives and ultimately lead to poorer quality risk assessments. For example, platforms that do not have to absorb any credit losses on defaulted loans would have the incentive to grant as many loans as possible to maximize fees earned. Or if a platform charges fees to borrowers based on risk, there would be the incentive to grant more higher-risk loans to attempt to maximize fees.

At the same time, if platforms earn fees based on servicing loans, then the incentive would be to grant loans that perform (and do not default) in order to maximize fees.

Attracting New Business Based on Investor Confidence

For lending platforms, there is less of a challenge bringing in new borrower business as long as the loan rates are competitively priced or priced below those of traditional banks or if the platform is targeting borrowers that are less of a priority for banks. However, the challenge in bringing in new investors for consumer loans seems to be the greater challenge. Reasons for the reduction in investor confidence of platforms could include one or more of the following:

- Other asset returns have increased relative to those earned by investing in loans on the platform.
- A greater percentage of FinTech actual loan defaults compared to expected, which could lead to a loss of confidence in the risk analysis and loan granting processes.
- The inability of investors to withdraw their investments early (even though there is no guarantee that it will be allowed).
- The platform is subject to legal action for the improper use of data or for the use of improper marketing techniques.
- Any event that causes a severe disruption to the platform's activities.

Low Barriers to Entry

Due to lack of regulation of the FinTech industry in many jurisdictions, the online nature of the services, and the common data sources used, there have been many new entrants into the industry. That reduces the opportunities for any individual platform to be profitable.

Additionally, there is always the threat that well-established banks could compete aggressively in the industry by establishing their own platforms. Banks would likely have access to more sophisticated resources pertaining to credit analysis and loan pricing.

Platform Profitability Risk

Many large platforms have incurred consistent losses each year, which calls into question whether they can continue to originate new loans into the future. Two arguments to support the continued existence include: (1) the FinTech industry is still in its early stages and requires further expansion to achieve the necessary economies of scale to become profitable, and (2) there is a specific objective to grow and avoid using profits in the short-term.

However, if losses continue and concerns about maintaining enough investors persist, platforms may have to alter their operations by originating and funding their own loans, providing loan guarantees, or using leverage, for example. In such cases, the platforms may become inherently more risky and must become more skilled in capital and risk management matters in order to survive in the long-term.

Growth of FinTech Credit

LO 78.3: Examine the implications for financial stability in the event that FinTech credit grows to account for a significant share of overall credit.

Benefits

The growth of FinTech credit could result in greater financial inclusion. There are two key underlying points here: (1) investing in FinTech loans could diversify an investment portfolio, and (2) borrowers such as self-employed individuals or small businesses, who have historically been restricted in the amount of financing obtained from traditional banks, may now have access to sufficient capital to grow their businesses.

With all credit services being transacted electronically rather than with paper and the traditional branch banking, FinTech could bring out lower transaction costs that will benefit borrowers in the form of lower financing costs and benefit lenders in the form of higher risk-adjusted returns.

Additionally, because the use of FinTech could result in lower transaction costs and greater convenience for customers, it may incentivize traditional banks to compete more directly by innovating (i.e., establish or acquire FinTech platforms) and/or operating more efficiently (i.e., discontinuing outdated IT systems and adopting newer online IT systems). Another possibility is for banks to cooperate with FinTech platforms by establishing partnership agreements to potentially improve risk analysis or target certain underserviced areas in the market (i.e., self-employed individuals), for example.

FinTech credit may offer newer and a greater variety of lending options (beyond those of traditional banking), some of which may be more appropriate and tailored to the needs of certain borrowers.

The emergence of FinTech as a major player would reduce the level of credit situated in the banking sector. It would serve as a backup source of credit in the economy. For example, if there are negative effects that are specific only to the banking sector (i.e., unsystematic risks) that significantly reduce its ability to lend during an economic crisis, then FinTech could potentially come to the rescue.

Assuming that FinTech platforms and traditional banks remain relatively separate in their operations, it should shield the FinTech industry from risks specific to banks. However, some banks are starting to provide operational, loan origination, and referral services to FinTech platforms, which increases their dependence on banks and may make the FinTech industry more vulnerable to the same risks as banks.

Unlike traditional banks, the FinTech industry is not exposed to maturity mismatch with its lending so it may serve as a source of credit should the economy otherwise be subject to a major liquidity shock. FinTech platforms tend to lend almost exclusively in the domestic market so compared to banks, they will be far less impacted by international shocks.

Like traditional loans, FinTech credit loans may be securitized, which allows for active trading of the resulting securities and funding to borrowers from a wider range of investors.

Risks

With more competition in the lending market with the growth of FinTech, it may significantly cut traditional banks' revenue and profits, which would lower their access to capital. It may force them to take on more risk to maintain market share or compensate for losses, which could be demonstrated by weaker overall lending standards (in well-developed credit markets), for example.

Banks may be taking on incremental operational and reputational risk by working with FinTech platforms, using electronic credit models, and outsourcing IT to third-parties. The operational risk is already there for many banks but would be exacerbated as a result of FinTech. Some banks may be involved in loan origination for FinTech platforms and then involved in subsequent FinTech loan sales to investors, all of which would be largely unregulated. Should borrowers or investors suffer significant losses due to those transactions, the banks could suffer from reputation risk for being viewed as operating outside of proper credit regulation.

The growth of FinTech may also promote procyclical credit provisions. It would manifest itself in more credit being available (i.e., weaker lending standards) when it is needed less in an economic upturn, but less credit being available when it is needed more in a downturn.

Should there be a reduction in FinTech lending, there is the issue of replacing the credit within the FinTech sector or through traditional banks. Regarding the FinTech sector, FinTech credit tends to be very concentrated within domestic markets so it would likely be challenging to find replacement credit on a timely basis. Regarding traditional banks, borrowers that are likely to access FinTech are often those who would not normally be able to obtain sufficient credit through traditional banks (i.e., small business owners or self-employed individuals) so it is not likely that they will be able to find replacement credit outside of FinTech.

The nature of FinTech credit would make it more difficult for regulators to properly monitor activities given the likely lack of reporting requirements and supervision. Because FinTech's activities may largely be unregulated, government policy actions related to strengthening the credit industry during an economic downturn, for example, may be ineffective. FinTech lenders would not be able to take advantage of public safety measures such as emergency liquidity (from the central bank) that would be available to traditional banks.

With securitization, the dependency between FinTech and the rest of the financial markets increases, thereby reducing FinTech's protection from risks faced in the general financial markets (and vice versa). In addition, the repackaging of FinTech loans could make the financial markets even less transparent from both an investing and a regulatory perspective.

Key Concepts

LO 78.1

The FinTech industry may develop due to the following supply reasons:

- FinTech lenders are likely to go further beyond conventional lenders in their use of technology, ultimately resulting in stronger client service.
- The use of an online business model for FinTech platforms typically has small upfront costs. FinTech lenders may be able to operate in very much the same way as conventional lenders, yet avoid their large fixed costs as well as the regulatory constraints.
- FinTech lenders may benefit from some market opportunities left untapped by traditional lenders and potential tax and regulatory incentives.

The FinTech industry may develop due to the following demand reasons:

- Greater use of online services by many younger customers and those in certain emerging markets.
- Loss of trust in traditional lenders in the aftermath of their failures to provide credit to borrowers during the financial crisis.
- FinTech loans may be appealing to investors who view FinTech lending as investing in an alternative asset class that may provide higher returns and lower risk.

Possible impediments to development of the FinTech industry include:

- Traditional banks have been in the online banking world for many years and some customers may not be willing to switch to an "unknown" digital lender.
- Considerable uncertainty exists as to whether emerging FinTech lenders would survive an economic downturn.
- Regulatory requirements could severely limit the growth of FinTech in jurisdictions where the licensing requirements are overly onerous or where interest rate limits apply.

LO 78.2

Traditional P2P lending platforms establish an online presence whereby borrowers and lenders may interact directly with each other.

The potential borrower makes an initial loan application on the online platform by providing the required information, which is reviewed and approved by the platform. From there, only the approved applications will go into the pool from which potential lenders may select the loan(s) they want. At that point, the loan contracts are established directly between the borrower and lender. From the borrower and/or lender, the platform operator takes fees such as for loan setup or loan repayments.

In general, borrowers establish the maximum rate for loans and lenders establish the minimum rate. The platform operator uses the information together with the loan amounts to match borrowers and lenders.

The majority of platforms allow for partial or full pre-payment of loans on a penalty-free basis.

Should a borrower be potentially delinquent on a loan; at the point of delinquency, the platform may start charging additional fees to the lender. Some platforms have methods to deal with credit losses, which could be in the form of insurance or guarantee/provision funds that provide partial or full coverage of the loan portfolio.

Should lenders wish to exit their loan investments, some jurisdictions allow those creditors to do so by paying fees to the platform and on the condition that other lenders will take over those loans.

The notary model involves a partnership agreement between a fronting bank and the lending platform because the former actually originates the loans. The loans are then sold or assigned by the fronting bank directly to interested lenders or through a platform subsidiary (securitization) to institutional investors.

With the guaranteed return model, the lending platform guarantees the principal and/or interest on the loans.

The balance sheet model involves the lending platform operating much the same way as a non-bank lender; it requires capital (i.e., debt, equity, securitization) to originate loans but it also retains the loan receivables as assets.

Invoice trading platforms providing recourse factoring have become popular because they include perks such as automatic invoice processing, less delay between invoice processing and cash payment, and a lower level of business activity required.

Microfinancial benefits include:

- Lower financing costs for borrowers, in theory, through the extensive use of computerization and automation. Although there seems to be a wide dispersion of interest rates.
- Higher returns for lenders, in theory, because quantifying the benefit is difficult.
- User convenience due to the computerized environment and the very streamlined process that may lead to extremely timely loan offers.
- Assisting existing borrowers by offering additional financing when needed (i.e., invoice trading platforms), addressing the needs of "forgotten" borrowers such as self-employed individuals and small business owners, and reaching out to new borrowers in emerging market economies.

Microfinancial risks include:

- A few platforms take on leverage risk in that they use internal resources to fund loans or provide return guarantees. Some platforms are now providing investors with the ability to withdraw amounts early; there is the risk that investors may expect liquidity even though it is clearly stated that it is not guaranteed.
- Operational risks such as cyber risks given the extensive use of electronic data, service disruption risks relating to an external provider of data storage, and fraud risk (i.e., money laundering, Ponzi schemes).
- Potentially lower credit risk assessment quality. Many FinTech platforms likely do not have detailed borrower information such as income, assets, and liabilities, and some FinTech platforms use exclusively hard data sources and do not consider soft credit risk factors.

- Inappropriate business model incentives that may cause more loans to be granted or more high-risk loans to be granted to maximize fees earned.
- Difficulty in attracting new investors for consumer loans if investor confidence in the platforms is low due to reasons such as low returns, higher default rates, and inability to withdraw investments early.
- Low barriers to entry reduce the opportunities for any individual platform to be profitable. In addition, there is always the threat of traditional banks beginning to aggressively compete with the online platforms.
- Platforms have generally incurred consistent losses each year, which calls into question whether they can continue to operate in the long-term. The result may be that platforms will have to alter their operations by originating and funding their own loans, providing loan guarantees, or using leverage, for example. In such cases, the platforms may become inherently more risky.

LO 78.3

With the potential growth of FinTech credit, some of the benefits include:

- Introducing greater financial inclusion.
- Lowering transaction costs.
- Incentivizing traditional banks to compete more directly by innovating and/or operating more efficiently.
- Providing newer and a greater variety of lending options.
- Reducing the level of credit concentrated in the banking sector.
- Serving as a source of credit should the economy be subject to a major liquidity shock. They are also minimally impacted by international shocks.

At the same time, some of the risks include:

- The increased competition may significantly cut traditional banks' revenue and profits, which may force them to take on more risk to compensate and ultimately lead to weaker lending standards.
- Banks may be taking on incremental operational and reputational risk by working with FinTech platforms, using electronic credit models, and outsourcing IT to third-parties.
- The growth of FinTech may also promote procyclical credit provisions.
- Should there be a reduction in FinTech lending, because FinTech credit tends to be very concentrated within domestic markets, it would likely be challenging to find replacement credit on a timely basis.
- The nature of FinTech credit would make it more difficult for regulators to properly monitor activities. The lack of regulation means that government policy actions related to strengthening the credit industry during an economic downturn would not be effective or public safety measures such as emergency liquidity would not be available.
- With securitization, the dependency between FinTech and the rest of the financial markets increases, thereby reducing FinTech's protection from risks faced in the general financial markets (and vice versa).

Concept Checkers

1. For FinTech platforms, the extent to which the underlying financial activity may be standardized is most likely limited by which of the following factors?
   A. Legal framework.
   B. High upfront costs.
   C. Customer reluctance.
   D. Potential competition from banks.

2. Which of the following FinTech credit platforms is characterized by matching borrowers with lenders with the loan being originated by a partnering bank?
   A. Notary model.
   B. Balance sheet model.
   C. Guaranteed return model.
   D. Traditional P2P lending model.

3. In which country is the notary model least likely to be utilized by FinTech lending platforms?
   A. Korea.
   B. Canada.
   C. Germany.
   D. United States.

4. Compared to traditional banks, FinTech credit platforms are likely more vulnerable to which of the following risks?
   A. Fraud risk.
   B. Cyber risk.
   C. Liquidity risk.
   D. Third-party service provider risk.

5. For an economy with a well-developed credit market, which of the following points is a benefit resulting from the growth of FinTech credit platforms?
   A. Greater access to credit.
   B. Procyclical credit provision.
   C. Diversify sources of funding.
   D. Greater concentration of credit in one sector.

Concept Checker Answers

1. **A** Examples of standardized activities include digital identification and standardized electronic contracts. The extent of standardization within a jurisdiction is primarily limited by the legal framework.

   FinTech platforms typically have low upfront costs. The nature of FinTech and its digital innovations is more likely to result in customer acceptance of standardization. Potential competition from banks is not a relevant factor in determining the extent of standardization.

2. **A** The notary model is similar to the traditional P2P lending model in that it matches borrowers with lenders but it requires a fronting bank to originate the loan.

3. **B** The notary model is the most commonly used model in Germany and Korea and it is also common in the United States.

4. **B** Given that FinTech credit platforms generally rely more on new electronic processes compared to traditional banks, the electronic processes are generally more vulnerable to cyber risk.

   Fraud risk, liquidity risk, and third-party service provider risks are common to both FinTech credit platforms and traditional banks. The exposure to such risks depends on the nature of activities undertaken by each.

5. **C** In diversifying the sources of funding, more alternative funding options are made available to borrowers. Some of those options may be more tailored to borrowers' specific needs.

   In a well-developed credit market, greater access to capital may lead to a potential decrease in lending standards. Procyclical credit provision is a risk resulting from the growth of FinTech; it manifests itself in excess credit provided in a market upturn and a deficiency in credit (when it is needed most) in a market downturn. The growth of FinTech credit platforms allows a lower concentration of credit in the banking sector, which could be beneficial if the banking sector is subject to unsystematic risk.

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

The Gordon Gekko Effect: The Role of Culture in the Financial Industry

Topic 79

Exam Focus

In this topic, we describe corporate culture and the role it plays in financial malfeasance and misdeeds, drawing on an analogy to the movie *Wall Street* and the Gordon Gekko character played by Michael Douglas. This topic is descriptive, explaining both the role culture has played in the downfalls of several firms, as well as measures society (and regulators) should take to identify and change corporate cultures. It is not as simple as corporate culture alone though, as the environment also influences human behavior. Both corporate culture and the environment can lead to excessive risk taking and, at the extreme, fraudulent behavior. For the exam, know how culture is influenced not only from top managers, but also from the types of workers who are hired (i.e., top down versus bottom up). Also, understand how culture can lead to excessive risk taking. In addition, be able to describe the way culture influenced outcomes for firms such as Lehman Brothers and AIG. The financial crisis of 2007–2009 shined a light on corporate culture as firms such as Lehman Brothers failed, due in part to a corporate culture that would not acknowledge failings either to outsiders or to those inside the firm who might have objected.

Influencing Corporate Culture

LO 79.1: Explain how different factors can influence the culture of a corporation in both positive and negative ways.

In the movie *Wall Street* (1987)[1], Gordon Gekko, played by Michael Douglas, says:

> The point is, ladies and gentleman, that greed, for lack of a better word, is good. Greed is right, greed works. Greed clarifies, cuts through, and captures the essence of the evolutionary spirit. Greed, in all its forms, greed for life, for money, for love, knowledge, has marked the upward surge of mankind. And greed, you mark my words, will not only save Teldar Paper, but that other malfunctioning corporation called the USA.

This monologue, based on a commencement address made by Ivan Boesky (who was convicted of insider trading 18 months later) at U.C. Berkeley in 1986, has become part of popular culture. It inspired legions of people to enter the field of finance, despite the fact that Gekko was the villain in the film and his plot was foiled by his young protégé. But the

1. *Wall Street*, directed by Oliver Stone (20th Century Fox, 1987).

"Gekko effect," and the culture of greed that goes along with it, lives on in corporations and institutions. Corporate culture can instill values in employees that make financial crimes and misdemeanors more likely.

Corporate Culture from the Top Down

O'Reilly and Chatman (1966)[2] define corporate culture as "a system of shared values that define what is important and the norms that define appropriate attitudes and behaviors for organizational members." Schein (2004)[3] focuses more on the learned assumptions of people in a group that help new group members think and feel in relation to the group's problems. The values of an organization, and its culture, ultimately define the group. One can think of culture more as biological, than economic, in the sense that it propagates itself. Culture also spreads, like an epidemic. Culture is spread through:

- Group leaders (the root source of the cultural epidemic).
- Group composition (the population through which the epidemic spreads).
- The group environment (which forms the group's response to the epidemic).

Leadership, or the authority that comes from the top of an organization, shapes culture as much or more than financial incentives. Charismatic leaders, like Gekko, garner authority via a strong, forceful personality. Traditional leaders garner authority through established customs. Authority figures establish proper behaviors, both negative and positive, of those below them through social sanctions (e.g., praise or reprimand, approval or disapproval). In some cases, like the military, people subordinate themselves to the will of others out of the belief that it will assist in the achievement of the goals of the group.

One question that arises, and can be answered to some degree with academic research, is how large must the financial incentive be to entice someone to behave badly? The answer, based on research, appears to be that there must be something else in the culture, beyond financial incentive, to entice bad behavior. Two famous examples from social sciences research support this conclusion. They are:

- In a study by Milgram (1963)[4] 26 out of 40 subjects delivered what they believed was a high voltage, potentially lethal, electric shock to victims, at the suggestion of the experimenter. All of the subjects expressed doubt and concern, three appeared to have seizures and a result of the stress induced by the situation, but they all administered the shock anyway. The financial reward was $4.00 plus carfare, which equates to approximately $50.00 today. Thus, financial incentive cannot explain the behavior.

2. Charles A. O'Reilly and Jennifer A. Chatman, "Culture as Social Control: Corporations, Cults, and Commitment," in *Research in Organizational Behavior*, vol. 18, ed. Barry M. Staw and L.L. Cummings (Greenwich, CT: JAI Press, 1996), 157–200.
3. Edgar H. Schein, *Organizational Culture and Leadership* (San Francisco, CA: Jossey-Bass, 2004).
4. Stanley Milgram, "Behavioral Study of Obedience," *The Journal of Abnormal and Social Psychology* 67, no. 4 (October 1963): 371–78.

- A Stanford psychology professor, Phillip Zimbardo, created a "prisoners and guards" study in 1971 (Haney, Banks and Zimbardo 1973a, b)[5,6]. Participants were randomly assigned the roles of prisoners or guards. Zimbardo played the role of prison superintendent. Guards began treating prisoners inhumanely almost immediately. Verbal abuse, manipulated bathroom privileges and sleeping conditions, and nudity used to humiliate prisoners were all used by the "guards." The experiment was terminated after six days at the urging of Zimbardo's wife, who was interviewing subjects. The study participants were paid $15.00 per day, which equates to approximately $90.00 today, again not likely a financial incentive big enough to explain the guards' behavior.

One of the lessons learned from these and other studies is that financial incentives alone are not enough to explain bad behavior. In the Milgram study the subjects, despite physical and mental distress of their own, acted on the commands of the authority figure. In the Zimbardo study, subjects acted with enthusiasm, fulfilling the roles they believed were expected of them by the authority, "prison superintendent" (and professor) Zimbardo. In both cases the financial incentive was minimal. There is a type of moral hazard that emerges, even if (or perhaps because of) the authority has a good track record. People are taught that when experts speak, they are correct. So if, like in the cases of the Milgram and Zimbardo studies, the authority figure seems okay with the behavior, people may act, as Shiller (2005)[7] puts it, "from people's past learning about the reliability of authorities."

However, just as corporate leaders may encourage bad behavior and promote goals which are immoral, unethical, and in some cases even irrational, they also can encourage employees to be more productive, increasing the competiveness of the firm.

Corporate Culture from the Bottom-Up

The people within a system (i.e., the composition) also influence the culture. Firms hire people and, during the process, filter out other qualified people. This filtering process can impact culture. For example, beginning in the 1980s, investment banks started deliberately targeting graduates from elite schools such as Harvard and Princeton. These hires brought their social values with them and as bankers retired, these values became the norm at Wall Street firms, according to a study by Ho (2009).[8] The high Wall Street compensation levels were perceived as appropriate for "members of the elite" tolerating the personal risk of job insecurity and the potential to be let go in these investment banks.

Company managers recruit people who they believe will be useful to the organization. While choosing from a diverse pool of applicants, companies often choose people who reinforce the corporate culture that already exists. These people then succeed in the culture and a feedback loop occurs, reinforcing the company's existing culture. In the best of circumstances this leads to a strengthening of culture and stronger performance. However, companies can also benefit from a diversity of thought that results from different

5. Craig Haney, Curtis Banks, and Philip Zimbardo, "Interpersonal Dynamics in a Simulated Prison," *International Journal of Criminology and Penology* 1 (1973): 69–97.
6. Craig Haney, Curtis Banks, and Philip Zimbardo, "A Study of Prisoners and Guards in a Simulated Prison," *Naval Research Reviews* 9 (1973): 1–17.
7. Robert J. Shiller, *Irrational Exuberance*, 2nd ed. (Princeton, NJ: Princeton University Press, 2005).
8. Karen Ho, *Liquidated: An Ethnography of Wall Street* (Durham, NC: Duke University Press, 2009).

backgrounds, ethnicities, and so on. This can help a company avoid "group think." There is an important place in modern corporations, especially in uncertain economic times, for whistle blowers, devil's advocates, innovators, and for those whose thoughts and ideas run contrary to the norm (i.e., the existing corporate culture).

Culture and the Environment

Regulation, the economic climate, the competitive environment, and many other factors also affect culture. For example, consider driving fatalities in the United States. Despite significantly more drivers, more miles driven, and the same propensity for risk taking, fatalities have decreased in the last 40 years. That is due to environmental factors. Cars have become safer (material culture), the police enforce speed limits (regulatory culture), and there is a stigma associated with driving while under the influence of alcohol (social culture).

Corporate Culture and Financial Risk Management

LO 79.2: Examine the role of culture in the context of financial risk management.

Firms, including financial firms, often hire "go-getters," more aggressive people with higher levels of risk tolerance. The thought is that they have the personality and competitive nature to move a firm forward. This personality type is drawn to riskier activities, what sociologist Stephen Lyng refers to as "**edgework**" (Lyng 1990).[9] Sports enthusiasts who skydive and do other dangerous activities get a certain pleasure from being one of the few who can, relative to the average person, navigate these dangerous waters. These individuals voluntarily take risks, without necessarily expecting a reward for that risk.

Sociologist Charles W. Smith recently used this idea of edgework to compare financial market traders to sea kayakers (Smith 2005).[10] While people drawn to higher-risk activities view themselves as exceedingly independent, they actually, according to Lyng, feel solidarity with fellow edgeworkers and at odds with the broader culture. In finance, this can manifest as a split between the trading desk (and perhaps upper management) and the rest of the firm. While executives may encourage risk aversion, they often seek out risk in their own lives, resulting in a "do as I say, not as I do" situation.

Contrast risk management in the insurance industry versus the banking industry. Revenue in the insurance industry is in large part determined by regulation. Insurance companies have an incentive to manage risks and protect against the downside. Bank earnings are more variable and are tied to bank size and the use of leverage. This means historically that insurance companies are more conservative than banks.

In the financial culture, protestors, regulators, and other dissenting opinions are often ignored. Criticisms are diminished, discounted, and dismissed. But market participants,

9. Stephen Lyng, "Edgework: A Social Psychological Analysis of Voluntary Risk Taking," *The American Journal of Sociology* 95, no. 4 (January 1990): 851–86.
10. Charles W. Smith,"Financial Edgework: Trading in Market Currents," in *Edgework: The Sociology of Risk Taking*, ed. Stephen Lyng (London: Routledge, 2005).

whether investors, entrepreneurs, bankers, regulators, or executives, are all part of and shaped by the culture. After a crisis, such as that of 2007–2009, regulation is good, greed is bad. But when economic times are good, greed is good and regulation is unnecessary, and the cycle continues.

Provided an incentive to be good, individuals will be good, according to economists. Economic self-interest is a learned behavior. A Wall Street manager, driven by a bonus culture, will excel at some parts of the job (those that result in the reward, the bonus) and be less successful at those not rewarded, such as following the ethical guidelines of the firm. If the incentives change and reward ethical behavior, the same manager may behave differently. Behavior can be predicted based on a knowledge of incentives and economic self-interest. Spoken in the extreme, bad behavior results from incentive problems, and can be corrected once an appropriately designed system of rewards and punishments is constructed. Economists always look to incentives when investigating bad behaviors.

An example is the "strategic defaults" on mortgage loans during the financial crisis. As housing prices fell and borrowers were "underwater" (i.e., homes were worth less than their loans) on their mortgages, it made sense (i.e., there was an economic incentive) to default, whether one could afford to pay or not. However, what role did culture play in strategic defaults? A study by Guiso, Sapienza, and Zingales (2013)[11] found that survey respondents were 51% more likely to strategically default if they knew someone else who had done so. The finding was confirmed by a study (Goodstein et al. 2013)[12] that showed delinquency rates were influenced by zip code, controlling for income. The more delinquencies in the zip code, the greater the strategic defaults.

Incentives and culture are inextricably linked. It is not possible to single out one or the other as the culprit for bad behavior.

Analyzing and Improving Culture

LO 79.3: Describe the framework for analyzing culture in the context of financial practices and institutions.

An alternative to the efficient markets hypothesis (EMH) is the **adaptive markets hypothesis** (AMH) (Lo, 2004, 2013).[13,14] In the AMH, individuals compete for scarce resources. These individuals adapt to both their past and current environments. Like people sort themselves based on values into political parties, they also sort themselves into professions. For example, those who value fairness might choose jobs where they can fight for fairness (e.g., teachers of under privileged children or sports referees). In contrast, those

11. Luigi Guiso, Paula Sapienza, and Luigi Zingales, "Does Culture Affect Economic Outcomes?" *Journal of Economic Perspectives* 20, no. 2 (Spring 2006): 23–48.
12. Ryan Goodstein et al., "Contagion Effects in Strategic Mortgage Defaults" (GMU Working Paper in Economics no. 13-07, January 2013), http://ssrn.com/abstract=2229054.
13. Andrew W. Lo, "The Adaptive Markets Hypothesis: Market Efficiency From an Evolutionary Perspective," *Journal of Portfolio Management* 30, no. 5 (2004): 15–29.
14. Andrew W. Lo, "The Origin of Bounded Rationality and Intelligence," *Proceedings of the American Philosophical Society* 157, no. 3 (September 2013): 269–80.

who do not believe in fairness above all, may choose high pressure sales jobs or choose to teach in expensive boarding schools.

Context is also important to behavior. For example, in a study by Cohn, Fehr, and Maréchal (2014)[15], the impact of context on financial culture, based on the honesty of participants from a large international bank, was gauged based on a coin-tossing experiment. The 128 participants were split into two groups. Half of the subjects were asked seven questions about their jobs at the bank prior to the exercise, while the other half were asked seven non-banking questions. The authors induced the participants to apply the cultural standards of the banking industry by asking them about banking prior to the experiment. Those who were asked banking questions were significantly more dishonest during the exercise than the group that was asked non-bank questions. The non-bank question group displayed a level of honesty equal to those working in other industries (i.e., nonfinancial). However, individual values can allow one to resist a bad norm.

A study by Dyck, Morse, and Zingales (2013)[16] finds, using class action lawsuit data from 1996 to 2004, that fraud increased as the stock market increased in the first five or six years then declined after the dot.com bubble burst in 2001–2002. Ponzi schemes also increased during bull markets between 1988 and 2012, decreased after 2001–2002, and then increased again leading up to the 2007–2009 financial crisis (Deason, Rajgopal, and Waymire 2015).[17] The authors note that Ponzi schemes are more difficult to sustain in bear markets. Also, regulation and enforcement budgets often increase after bubbles burst (i.e., the dot.com and the housing market bubbles). The authors find that Ponzi schemes are more likely when there is an "affinity link" (i.e., a strong connection) between the offender and the victim, such as they are members of the same religion or are part of the same ethnic group, indicating that shared culture can be used for ill. Both studies indicate that culture is often a product of the environment (e.g., good versus bad economic times, perceived moral character and changing character of leaders such as CEOs, movie stars, politicians, and so on).

There are several examples of corporate culture and the role it has played in company failures in the financial industry. They include:

- **Long-Term Capital Management (LTCM).** LTCM had a strong corporate culture that was well-respected across the financial industry. Founders John Meriwether (a former head of bond trading at Salomon Brothers) and Robert Merton and Myron Scholes, future Nobel Prize in Economics winners, founded a company based on mathematical models that the industry perceived as ultra-safe and invincible, leading to extremely favorable credit terms and little to no margin requirements. In fact, the failure of LTCM may even be seen as the failure of the firm's creditors' corporate cultures, overconfident in their abilities to assess the risks of the firms to which they loaned money.

15. Alain Cohn, Ernst Fehr, and Michel André Maréchal, "Business Culture and Dishonesty in the Banking Industry," *Nature* 516, no. 7529 (December 2014): 86–89.
16. Alexander Dyck, Adair Morse, and Luigi Zingales, "How Pervasive Is Corporate Fraud?" (working paper, August 2013).
17. Stephen Deason et al., "Who Gets Swindled in Ponzi Schemes?" (unpublished paper, Goizeta Business School, Emory University, Atlanta, GA, 2015).

- **American International Group (AIG).** AIG's culture centered on its original chairman, Maurice "Hank" Greenberg. Compensation plans rewarded loyalty to the firm. Much of AIGs success was attributed to excellent insurance underwriting. That underwriting was monitored across divisions by Greenberg himself. When, in 2005, the board replaced Greenberg due to "headline risk" that Greenberg may have played a role in financial irregularities, the new chair, Martin Sullivan, assumed the vigorous risk management culture would remain without Greenberg's watchful eye. Without Greenberg, however, the company's actions grew more aggressive and risky [selling billions of dollars of credit default swaps (CDS)], ultimately leading to a government bailout in 2008. In fact, AIG's strong risk management culture may have led to its failure in the sense that firm leaders believed that strong risk management and high growth in a traditionally lower risk and lower growth industry like insurance, would translate into higher risk activities such as selling CDSs. As a result of its confidence in its own risk management practices, billions of dollars of toxic assets were allowed to appear on AIG's balance sheet.
- **Lehman Brothers.** The culture at Lehman Brothers was such that flaws were not only concealed from regulators and the public, but from those inside the organization as well. For example, the use of the accounting trick known as "Repo 105" allowed the firm to show repurchase agreements, a source of financing, as a sale of an asset instead, making the firm look more financially sound than it was. The misleading accounting practice was hidden by an internal hierarchy within the firm, from both external and internal people who might have objected. The hierarchical corporate structure which chose secrecy above transparency (a global financial controller expressed concern about reputational risk regarding the Repo 105 accounting trick, but was shut down) contributed to Lehman's downfall. Lehman managers concealed flaws rather than attempted to remedy them.
- **Société Générale.** In the case of French bank Société Générale, inattention and neglect, inherent in the corporate culture, led to the bank losing nearly €6.5 billion due to rogue derivatives trader, Jerome Kerviel. The bank nearly failed. An investigation found a lack of attention to risks and to the processes and procedures intended to stem those risks, existed up to four levels of management above Kerviel. Looking at the bank's history, though, reveals a bit more about its culture of inept managers. Like U.S. investment banks hiring Ivy League graduates, Société Générale hired elite French graduates. But the graduates focused their attention on retail banking due to connections with policymakers in the public and private sectors, and not on the Corporate Investment Banking division in which Kerviel worked. Kerviel was not from an elite university and thus was paid little attention, despite the fact that he made large sums of money and traded with enormous sums at stake. The firm did not value trading in its culture and put low priority on managing the trading desk.

Sadly, regulatory culture is not immune to these cultural failings. For example, the Securities and Exchange Commission (SEC) had received several warnings about Bernie Madoff's Ponzi scheme but failed to act. The SEC had a hierarchical corporate structure that impeded the flow of information from one division to another. This fact meant that SEC offices that were getting complaints about Madoff, did not talk to each other and did not even know that they were each investigating Madoff (i.e., the Northeast Regional Office and the Office of Compliance Inspections and Examinations). Low morale, a distrust of management, and a compartmentalized, hierarchical, and risk averse culture that feared public scandal contributed to the shocking slowness with which the SEC caught on to Madoff's scheme. The SEC has since tried to remedy some of the failings in its corporate culture.

LO 79.4: Analyze the importance of culture and a framework that can be used to change or improve a corporate culture.

Any framework that is used to improve culture must measure the culture. The old adage "one cannot manage what one does not measure" is applicable. One example is the way in which the National Transportation and Safety Board (NTSB) conducts post-crash analysis. The NTSB conducts a thorough investigation of the causes of a crash, publishes the report and makes recommendations for changes that will improve airplane safety going forward.

Could we use that same framework to improve corporate culture in financial firms? While financial crashes are less deadly, they too must be investigated, analyzed, and learned from. Perhaps a "Capital Markets Safety Board" is in order, based on the impact of the 2007–2009 crash on peoples' lives. The board would investigate, report, and archive the accidents that occur in financial markets and make recommendations for preventing those accidents in the future.

In the Madoff story, much has been written on what happened, but not why it happened. How did a wealthy and respected business person ultimately commit such a shocking and devastating crime? In other words, what was the cultural setting in which Madoff operated that allowed this crime? Even sophisticated institutional investors were duped, but why? Was it a culture of greed, or exclusivity? Was it pressure to perform in a low-yield environment (which also, in some part, led to the 2007–2009 financial crisis)? Was it Madoff's power and a desire to "be like him?" Without a forensic analysis of the cultural implications of a failure like Madoff's, we may be bound to repeat the mistakes of the past. If the financial market had a safety board to dig deep and analyze the underlying, cultural causes for a failing like Madoff's, could we avoid a repeat?

Looking at the NTSB culture, it is a rare one of trust, high morale, and teamwork. It is an individualistic culture with a legal-rational basis (instead of charismatic or authoritarian leaders) for its authority but it also has cohesive, accountable small teams who have a shared purpose. The NTSB is an admired regulatory agency where people want to work and to contribute.

Psychologist Philip Zimbardo (2007)[18] argues that the best way to protect a firm against the Gordon Gekko effect is to "resist situational influences." Zimbardo is the Stanford psychologist who ran the prison experiment described previously. His wife was a "voice of reason" that he trusted, allowing him to shut down the experiment before it got totally out of control. Zimbardo has studied culture since then, trying to understand how culture can lead seemingly good people to do bad things. Zimbardo suggests behaviors that can be used to reduce the effect of a destructive culture on an organization. Zimbardo's suggestions include:

- A willingness to admit mistakes.
- A refusal to respect unjust authority.
- The ability to consider the effect of one's actions on the future, not just the present.
- Promoting individual values of honesty, responsibility, and independence of thought.

18. Philip Zimbardo, *The Lucifer Effect: Understanding How Good People Turn Evil* (New York: Random House, 2007).

It may be difficult to change the culture of a large organization, but it is possible. A dual process of moral and ethical decision-making is important.

The AMH, described previously, provides a framework for thinking systematically about changing culture. One step toward achieving a cultural shift is changing the language from the vague and seemingly impossible "change the culture" to a more concrete and actionable "behavioral risk management" model. For example, Andrew Lo (1999)[19] suggests the mnemonic SIMON (select, identify, measure, optimize, and notice) as a process for managing the risk of a financial portfolio. SIMON could also be applied to behavioral risk management as in:

1. **Select** the behavioral risk that should be managed. For example, managers who only want to hear "yes," a lack of respect for compliance procedures, cutting ethical corners to achieve profitability or growth goals, and so on.

2. **Identify** the objective function and constraints to managing the behavior such as the company's short-run goals or the values of the corporation.

3. **Measure** the "statistical laws of motion" for managing behavior (e.g., use something like the dual process theory for moral reasoning or the Office of Personnel Management (OPM) Global Satisfaction Index). This is the weakest link in the analogy to manage risk in a behavioral setting because quantifying human behavior is difficult, if not impossible. Currently, measures such as psychological profiles, social network maps, and job satisfaction surveys are the purview of human resources, not risk managers and corporate boards of directors.

4. **Optimize** the objective function subject to the constraints. This step will uncover the best compensation schemes as well as compliance procedures, reporting requirements, and so on to change the culture (i.e., align the culture with the objectives).

5. **Notice** (most importantly notice) changes to the system to ensure that the behavioral risk management practices are reaching the desired outcomes. The firm must repeat these five steps as needed to achieve the firm's objectives.

And back to the role incentives play in culture, if managers are compensated only on profitability and not on firm stability, then it is clear where they will expend their efforts, and it is not on managing risks.

At least theoretically, one can consider a model that predicts manager behavior based on a number of variables such as the compensation structure (i.e., reward), potential losses, competitive and peer pressures, regulation, career risks, and so on. If it were possible to estimate a model like this that predicts behavior, then it would be possible to define the culture quantitatively. It would be possible to identify risks and better manage the behavior of those individuals (and overall cultures) with high "betas" on reward or competitive pressures and low betas on regulation and potential losses. Also, as noted previously, culture changes with the environment. Thus, regulators should expect behaviors to change when, for example, yields are low and competition is fierce. Regulators should act according to changes they see and expect to see based on a changing environment.

19. Andrew W. Lo, "The Three P's of Total Risk Management," *Financial Analysts Journal* 55, no. 1 (January/February 1999): 13–26.

Professor's Note: Think of this like a regression model where, for example, a manager's risk appetite is the dependent variable and all the factors that may affect risk taking, like compensation and regulation, are independent variables. The "betas" are the factor loadings (i.e., the relative importances) of the various independent variables on risk appetite.

The Dutch central bank, De Nederlandsche Bank (DNB), has already moved, following the 2007–2009 financial crisis, in this direction. In a document entitled, "The Seven Elements of Ethical Culture," the bank details why it is important to include ethical behavior and culture in bank supervision. The bank has created the Expert Centre on Culture, Organization, and Integrity, has hired psychologists, and has launched research projects to develop methods for supervising corporate culture in the Dutch banking system. The New York Federal Reserve Bank has also taken steps, conducting and publishing a survey on the supervision of large financial institutions that are under the authority of the NY Fed.

Regulators must also play a role in setting the tone for corporate culture and must not get sucked up in the culture itself. Regulators must understand the culture but remain immune to it. This is not easy (e.g., the SEC and Bernie Madoff's Ponzi scheme).

Professor's Note: There is a theory called "regulatory capture" that suggests that in some cases regulators come to be dominated by the industries they regulate.

Along with compensation, firms can use things such as peer review, public recognition or embarrassment, and the use of social networks to influence behavior and culture. For example, if a firm determines that prestige in the firm is associated with risk taking, the firm might appoint a Chief Risk Officer (CRO) who reports directly to the board. The firm would protect the CRO, making it so he could not be removed from the position except by the board. The CRO could be given, for example, the temporary authority to relieve the CEO of duties if it is determined that risk levels are too high and that the CEO has not responded to the CRO's requests to reduce risks. Notice that it is important that the CRO be given both the authority and the protection to accomplish the firm's goals in terms of changing the risk-taking culture.

A firm might take a more drastic approach, making the upper management of the firm jointly liable for lawsuits against the firm. This would make the individuals much more inclined to carefully monitor the risk-taking activities of the company. While this would reduce risks, it would also likely reduce returns, which may not make shareholders happy. Balancing these competing interests and tradeoffs between risks and rewards is an age-old problem and in part determines the culture. However, behavioral risk models are more likely now than ever before as a result of big data, and advances in behavior and social sciences.

Professor's Note: Unlike some readings where the LOs are very directly related to the article or chapter, in this case, it is more unclear. In this topic, it is important to get the overall point—that corporate culture is vital to the actions and behaviors of financial firm managers and employees. For the exam, be able to apply these concepts to a situation or scenario regarding culture. The final LO regarding a framework that might be used to change or improve a culture is a significant one. Understanding the roles of incentives, competitive pressures, and lack of concern about losses or regulations are important to understanding how these factors might be changed to modify the culture of a firm.

Key Concepts

LO 79.1

Corporate culture may be defined as "a system of shared values that define what is important and the norms that define appropriate attitudes and behaviors for organizational members." Corporate culture can arise from the top down. In some firms top managers set the tone for excessive risk taking. Culture can also arise from the bottom up. For example, investment banks pride themselves on hiring from Ivy League schools, which comes with its own cultural influences. The environment and the health of the economy also influences culture. Culture can influence a firm in both positive and negative ways.

LO 79.2

Firms often hire aggressive people with higher levels of risk tolerance which affects the culture of the firm. The thought behind hiring these people is that they have the personality and competitive nature to move a firm forward. It may differ across industries, however. Risk management in the insurance industry is quite different than in the banking industry. Revenue in the insurance industry is in large part determined by regulation while bank earnings are more variable and are tied to bank size and the use of leverage. Insurance companies have an incentive to manage risks and protect against the downside and are thus generally more conservative than banks. According to economists, provided an incentive to be good, individuals will be good. Economic self-interest is a learned behavior. However, the environment, not just incentives, shapes behavior and corporate culture.

LO 79.3

It is possible to examine the role corporate culture plays in firms by considering several firms that have failed, or come to the brink of failure, due to cultural factors. Long-Term Capital Management (LTCM), American International Group (AIG), Société Générale, and Lehman Brothers all had problems but for different cultural reasons. One can examine corporate culture using these firms as examples. Regulators, such as the SEC's failure to realize, despite warnings, that Bernie Madoff was running a Ponzi scheme, are also subject to cultural risks.

LO 79.4

A more quantitative approach to behavioral risk models is needed. For example, one can use the approach that manages the risks in a financial portfolio to managing behavioral/cultural risks. This approach uses the mnemonic SIMON (select, identify, measure, optimize, and notice) as a process for managing the risk of a financial portfolio. SIMON could also be applied to behavioral risk management as in:

1. Select the behavioral risk that should be managed.
2. Identify the objective function and constraints to managing the behavior such as the company's short-run goals or the values of the corporation.
3. Measure the "statistical laws of motion" for managing behavior.
4. Optimize the objective function subject to the constraints.
5. Notice changes to the system to ensure that the behavioral risk management practices are reaching the desired outcomes.

This and other frameworks may be used to better understand and improve a firm's corporate culture.

Concept Checkers

1. Corporate culture is *most likely* spread through all of the following except:
   A. the environment in which the firm operates.
   B. the workers who are hired to work at the firm.
   C. the mission statement and company handbook of the firm.
   D. the managers of the firm.

2. Bob Johnson works for an investment bank. Managers talk about managing risks but clearly reward the workers who take the biggest chances. In fact, Johnson feels that his propensity for risk taking was assessed in his job interview and thus he exaggerated his comfort level with risky activities when interviewing. The company takes employees on corporate retreats where employees are expected to sky dive, rock climb, and engage in other exciting but risky activities. The concept of voluntary risk-taking as developed by Stephen Lyng is known as:
   A. disruption.
   B. boundary breaking.
   C. edgework.
   D. hazard labor.

3. People are more accepting of greed and less accepting of regulation when:
   A. the economy is strong.
   B. the economy is weak.
   C. the economy is in recession/depression but appears to be near a turnaround.
   D. the economy is nearing its peak but leading indicators indicate a contraction in the next six months.

4. Which of the following firms, based on a history of sound risk management practices, placed too much faith in its own risk management systems and either failed or was bailed out by the government as a result?
   A. Long-Term Capital Management.
   B. American International Group.
   C. Lehman Brothers.
   D. Société Générale.

5. A willingness to admit mistakes is part of the behavioral risk management framework suggested by:
   A. Andrew Lo.
   B. Philip Zimbardo.
   C. the National Transportation and Safety Board (NTSB).
   D. De Nederlandsche Bank (DNB), the Dutch central bank.

Concept Checker Answers

1. **C** Culture is spread through:
   - Group leaders (the root source of the cultural epidemic).
   - Group composition (the population through which the epidemic spreads).
   - The group environment (which forms the group's response to the epidemic).

   In some cases the mission statement and handbook may be relevant, but it is the environment and the people, the "live by example," that truly shapes the culture.

2. **C** Sociologist Stephen Lyng refers to "edgework" as risky activities that are voluntarily assumed. Some people voluntarily assume more risk and are provided with emotional pleasure as a result. Some sports enthusiasts who skydive and do other dangerous activities get a certain pleasure from being one of the few who can, relative to the average person, navigate these dangerous waters. These individuals voluntarily take risks, without necessarily expecting a reward for that risk.

3. **A** In the financial culture, protestors, regulators, and other dissenting opinions are often ignored. Market participants are part of and shaped by the culture. After a crisis, such as 2007–2009, regulation is perceived as good, and greed is perceived as bad. But when economic times are good, greed is good and regulation is perceived as unnecessary.

4. **B** American International Group's (AIG's) culture centered on its original chairman Maurice "Hank" Greenberg. Much of AIG's success was attributed to excellent insurance underwriting, which was monitored across divisions by Greenberg. When, in 2005, the board replaced Greenberg due to "headline risk," the new chair, Martin Sullivan, assumed the vigorous risk management culture would remain without Greenberg's watchful eye. Without Greenberg, however, the company's actions grew more aggressive and risky [selling billions of dollars of credit default swaps (CDS)], ultimately leading to a government bailout in 2008.

5. **B** Psychologist Philip Zimbardo argues that the best way to protect a firm against the Gordon Gekko effect is to "resist situational influences." Zimbardo suggests behaviors that can be used to reduce the effect of a destructive culture on an organization, including:
   - A willingness to admit mistakes.
   - A refusal to respect unjust authority.
   - The ability to consider the effect of one's actions on the future, not just the present.
   - Promoting individual values of honesty, responsibility, and independence of thought.

Self-Test: Risk Management and Investment Management; Current Issues in Financial Markets

10 Questions: 30 Minutes

1. Given the following information, what is the percent of contribution to VaR from Asset A? There are two assets in a portfolio: A and B.

Asset A marginal VaR:	0.05687
Asset A value:	$7,000,000
Asset B marginal VaR:	0.17741
Asset B value:	$4,000,000

A. 64.06%.
B. 24.27%.
C. 35.94%.
D. 63.64%.

2. A portfolio is composed of two securities and has the following characteristics:

Investment in X:	USD 1.8 million
Investment in Y:	USD 3.2 million
Volatility of X:	8%
Volatility of Y:	4%
Correlation between X and Y:	15%

The portfolio diversified VaR at the 95% confidence level is closest to:
A. $14,074.
B. $206,500.
C. $404,740.
D. $340,725.

3. The buy side and sell side of the investment industry have different characteristics when it comes to turnover, investment horizon, leverage, and risk measures used. Which of the following does not characterize the side of the investment industry that would be inclined to use VaR as one of their primary risk measures?
A. Long-term investment horizon.
B. High leverage.
C. Fast turnover.
D. Stop-loss rules are an important form of risk control.

4. SkyLine Airways has a defined benefit pension scheme with assets of $165 million and liabilities of $150 million. The annual growth of the liabilities is expected to be 4.5% with 2.4% volatility. The annual return on the pension assets has an expected value of 7.8% with 12% volatility. The correlation between asset return and liability growth is 0.35. What is the 95% surplus at risk for SkyLine?
   A. $24.97 million.
   B. $54.81 million.
   C. $18.84 million.
   D. $6.12 million.

5. Portfolio ACC has an expected return of 10%, volatility of 25%, and a beta of 1.2. Assume that the market has an expected return of 8% and volatility of 15%, and that the risk-free rate of return is 4%. What is Jensen's alpha for Portfolio ACC?
   A. 1.2%.
   B. 2.0%.
   C. 3.6%.
   D. 10.8%.

6. Linda Hernandez, FRM, is a hedge fund analyst for a prominent hedge fund allocation firm. Hernandez is concerned about potential measurement errors and various biases in reported hedge fund returns prior to 1996. Looking at hedge fund returns for the largest hedge funds from 1987 to 1996, how would performance be best characterized, and how would various measurement biases affect the performance?
   A. There were so many hedge fund managers not reporting that performance information is deemed unreliable.
   B. Large hedge fund returns were on par with equities, accompanied by a much higher standard deviation.
   C. Selection bias caused large hedge fund returns to have little correlation with the average return of hedge funds in commercial databases.
   D. Large hedge funds substantially outperformed equities, more than enough to account for any measurement biases.

7. A risk manager is reviewing accounting rule changes regarding expected credit loss (ECL) provisioning. When comparing and contrasting aspects of the corresponding IASB and FASB standards, which of the following statements is correct?
   A. The FASB standard will result in earlier and larger recognition of losses.
   B. Both standards differ when dealing with loans that have considerable credit deterioration.
   C. The FASB standard only requires the cost recovery method in order to provide a more conservative method for income recognition on delinquent loans.
   D. Under the IASB standard, ECL is reported under stage 3 when there is severe deterioration of credit quality, which requires classification into a high credit risk category.

8. When analyzing data using the process of machine learning, which of the following statements directly applies to the concept of overfitting?
   A. Overweighting scarcer observations may train the model to detect them more easily.
   B. Applying several layers of algorithms into the learning process may mimic the human brain.
   C. Complex models may describe random error rather than true underlying relationships in the model.
   D. Running several hundreds of thousands of models on different subsets of the model may improve its predictive ability.

9. In the event a clearing member defaults, a central counterparty (CCP) has a number of liquidity resources to guard against insolvency risk. Given the following liquidity resources, what is the loss sequence that the CCP will follow to cover potential losses?
   I. Initial margin paid to the CCP by each clearing member.
   II. Default fund contributions from non-defaulting members.
   III. CCP equity to mutualize large losses.
   IV. Default fund contributions from defaulting members.

   A. I, II, III, IV.
   B. I, IV, II, III.
   C. I, IV, III, II.
   D. IV, II, I, III.

10. A risk analyst is examining the various types of FinTech credit platforms. Which of the following platform descriptions *most likely* reflects the traditional peer-to-peer (P2P) lending model?
   A. The lending platform guarantees the principal, interest, or both on the loans.
   B. The lending platform establishes an online presence whereby borrowers and lenders may interact directly with each other.
   C. The lending platform operates much the same way as a non-bank lender where it requires capital to originate loans but it also retains the loan receivables as assets.
   D. There is a partnership agreement between a fronting bank and the lending platform, and the loans may be sold by the fronting bank directly to interested lenders.

Self-Test Answers: Risk Management and Investment Management; Current Issues in Financial Markets

1. **C** The component VaR factors in both the marginal VaR and the asset value.

   For Asset A: 0.05687 × $7,000,000 = $398,090.

   For Asset B: 0.17741 × $4,000,000 = $709,640.

   Asset A's percent of contribution to VaR is A's component VaR as a percent of total VaR: $398,090 / ($398,090 + $709,640) = 35.94%.

   Choice A is incorrect because it is the percent of contribution to VaR from Asset B.

   Choice B is incorrect because it is the Marginal VaR weight for Asset A.

   Choice D is incorrect because it is just the asset weight for Asset A.

   (See Topic 67)

2. **D** Step 1: Calculate the volatility of the portfolio.

   $\text{Variance}_{X,Y} = w^2_X\sigma^2_X + w^2_Y\sigma^2_Y + 2 \times w_X \times w_Y \times \sigma_X \times \sigma_Y \times \text{Corr}_{X,Y}$

   $\text{Variance}_{X,Y} = 0.36^2 \times 0.08^2 + 0.64^2 \times 0.04^2 + 2 \times 0.36 \times 0.64 \times 0.08 \times 0.04 \times 0.15$

   $\text{Variance}_{X,Y} = 0.00082944 + 0.00065536 + 0.000221184$

   $\text{Variance}_{X,Y} = 0.001705984$

   Standard deviation = $\sqrt{0.001705984}$ = 4.13%

   Step 2: Calculate the VaR.

   VaR = 1.65 × volatility × portfolio value

   VaR = 1.65 × 0.0413 × $5m

   VaR = $340,725

   (See Topic 67)

3. **A** The sell side of the investment industry uses VaR and stress tests as their primary risk measures. The buy side of the investment industry uses asset allocation and tracking error. The sell side has a short-term investment horizon, uses high leverage, and has fast turnover. Risk controls used are position limits, VaR limits, and stop-loss limits.

   (See Topic 68)

4. **A** Step 1: Calculate the expected surplus growth.

Expected surplus growth = growth in assets – growth in liabilities

Expected surplus growth = ($165m × 0.078) – ($150m × 0.045)

Expected surplus growth = $12.87m – $6.75m = $6.12m

Step 2: Calculate the variance then the standard deviation of the A&L.

$Var_{A\&L} = w^2_A\sigma^2_A + w^2_L\sigma^2_L - 2 \times w_A \times w_L \times \sigma_A \times \sigma_L \times Corr_{AL}$

$Var_{A\&L} = 165^2 \times 0.12^2 + 150^2 \times 0.024^2 - 2 \times 165 \times 150 \times 0.12 \times 0.024 \times 0.35$

$Var_{A\&L} = 392.04 + 12.96 - 49.896$

$Var_{A\&L} = 355.104$

Standard deviation = $\sqrt{355.104}$ = 18.84m

Step 3: Calculate VaR of the assets.

VaR = Z-Score × volatility

VaR = 1.65 × $18.84m

VaR = $31,086,000

Surplus at risk = expected growth in surplus – VaR

Surplus at risk = $6.12m – $31.086m = –$24.97m

Note: Although it is a negative, it is usually expressed as a positive figure as it is assumed that it is a shortfall.

(See Topic 68)

5. **A** The Jensen measure of a portfolio is computed as follows:

$\alpha = E(R_p) - \{R_F + \beta[E(R_M) - R_F]\}$

$\alpha = 10\% - [4\% + 1.2(8\% - 4\%)]$

$\alpha = 10\% - 8.8\%$

$\alpha = 1.2\%$

(See Topic 70)

6. **D** There were concerns about measurement errors and biases, but the hedge fund outperformance was more than enough to account for any such errors. Large hedge fund returns were highly correlated to the average return of hedge funds in commercial databases.

(See Topic 71)

7. **A** FASB requires the entire lifetime ECL to be recorded as a provision from the outset. As a result, the FASB standard will result in earlier and larger recognition of losses. The two standards are the same when dealing with loans that have considerable credit deterioration. FASB requires the use of either the cash basis, cost recovery method, or a combination of both in order to provide a more conservative and reliable method for income recognition on delinquent loans. Under IASB, stage 2 for a loan asset occurs upon severe deterioration of credit quality to require classification into a high credit risk category.

   (See Topic 73)

8. **C** Overfitting suggests that models that are very complex may describe noise or random error rather than true underlying relationships in the model. *Boosting* refers to overweighting scarcer observations to train the model to detect these more easily. *Deep learning* essentially mimics the human brain by applying several layers of algorithms into the learning process and converts raw data to identify complex patterns. *Bagging* describes the process of running several hundreds of thousands of models on different subsets of the model to improve its predictive ability.

   (See Topic 75)

9. **C** A CCP has the following liquidity resources to cover potential losses should a clearing member default (in the following sequence):

   1. Initial margin.
   2. Default contribution of defaulting member.
   3. Mutualization of large losses (i.e., CCP equity).
   4. Recovery (including default funds from non-defaulting members).
   5. Failure resolution.

   (See Topic 76)

10. **B** Traditional P2P lending platforms establish an online presence whereby borrowers and lenders may interact directly with each other. The notary model involves a partnership agreement between a fronting bank and the lending platform because the former actually originates the loans. With the guaranteed return model, the lending platform guarantees the principal, interest, or both on the loans. The balance sheet model involves the lending platform operating much the same way as a non-bank lender.

    (See Topic 78)

Formulas

Topic 62

investor risk premium: $E(R_M) - R_F = \bar{\gamma} \times \sigma_M^2$

security market line: $E(R_i) - R_F = \frac{cov(R_i, R_M)}{var(R_M)} \times [E(R_M) - R_F] = \beta_i \times [E(R_M) - R_F]$

Topic 63

Fama-French three-factor model:

$$E(R_i) = R_F + \beta_{i,MKT} \times E(R_M - R_F) + \beta_{i,SMB} \times E(SMB) + \beta_{i,HML} \times E(HML)$$

Fama-French model with momentum effect:

$$E(R_i) = R_F + \beta_{i,MKT} \times E(R_M - R_F) + \beta_{i,SMB} \times E(SMB) + \beta_{i,HML} \times E(HML) + \beta_{i,WML} \times E(WML)$$

Topic 64

fundamental law of active management: $IR \approx IC \times \sqrt{BR}$

Topic 66

$$\text{risk aversion} = \frac{\text{information ratio}}{2 \times \text{active risk}}$$

marginal contribution to value added = (alpha of asset) – [2 × (risk aversion) × (active risk) × (marginal contribution to active risk of asset)]

Topic 67

diversified VaR: $VaR_p = Z_c \times \sigma_p \times P$

individual VaR: $VaR_i = Z_c \times \sigma_i \times |P_i| = Z_c \times \sigma_i \times |w_i| \times P$

standard deviation of a two-asset portfolio: $\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2\, w_1 w_2 \rho_{1,2}\sigma_1\sigma_2}$

VaR of a two-asset portfolio: $VaR_P = Z_c P\sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2\, w_1 w_2 \rho_{1,2}\sigma_1\sigma_2}$

undiversified VaR: $VaR_P = \sqrt{VaR_1^2 + VaR_2^2 + 2VaR_1VaR_2} = VaR_1 + VaR_2$

standard deviation of equally weighted portfolio with equal standard deviations and correlations:

$$\sigma_P = \sigma\sqrt{\frac{1}{N} + \left(1 - \frac{1}{N}\right)\rho}$$

marginal VaR: $MVaR_i = \frac{VaR}{P} \times \beta_i$

component VaR: $CVaR_i = (MVaR_i) \times (w_i \times P) = VaR \times \beta_i \times w_i$

Topic 68

surplus = assets – liabilities

Δsurplus = Δassets – Δliabilities

return on the surplus:

$$R_{surplus} = \frac{\Delta Surplus}{Assets} = \frac{\Delta Assets}{Assets} - \left(\frac{\Delta Liabilities}{Liabilities}\right)\left(\frac{Liabilities}{Assets}\right) = R_{asset} - R_{liabilities}\left(\frac{Liabilities}{Assets}\right)$$

Topic 69

liquidity duration: $LD = \frac{Q}{(0.10 \times V)}$

where:

LD = liquidity duration for the security on the assumption that the desired maximum daily volume of any security is 10%
Q = number of shares of the security
V = daily volume of the security

Topic 70

Sharpe ratio: $S_A = \frac{\overline{R}_A - \overline{R}_F}{\sigma_A}$

where:
$\overline{R}_A$ = average account return
$\overline{R}_F$ = average risk-free return
σ_A = standard deviation of account returns

Treynor measure: $T_A = \frac{\overline{R}_A - \overline{R}_F}{\beta_A}$

where:
$\overline{R}_A$ = average account return
$\overline{R}_F$ = average risk-free return
β_A = average beta

Jensen's alpha: $\alpha_A = R_A - E(R_A)$

where:
α_A = alpha
R_A = the return on the account
$E(R_A) = R_F + \beta_A[E(R_M) - R_F]$

information ratio: $IR_A = \frac{\overline{R}_A - \overline{R}_B}{\sigma_{A-B}}$

where:
$\overline{R}_A$ = average account return
$\overline{R}_B$ = average benchmark return
σ_{A-B} = standard deviation of excess returns measured as the difference between account and benchmark returns

statistical significance of alpha returns: $t = \frac{\alpha - 0}{\sigma / \sqrt{N}}$

where:
α = alpha estimate
σ = alpha estimate volatility
N = sample number of observations
standard error of alpha estimate = $\sigma / \sqrt{N}$

Using the Cumulative Z-Table

Probability Example

Assume that the annual earnings per share (EPS) for a large sample of firms is normally distributed with a mean of $5.00 and a standard deviation of $1.50. What is the approximate probability of an observed EPS value falling between $3.00 and $7.25?

If EPS = x = $7.25, then $z = (x - \mu)/\sigma = (\$7.25 - \$5.00)/\$1.50 = +1.50$

If EPS = x = $3.00, then $z = (x - \mu)/\sigma = (\$3.00 - \$5.00)/\$1.50 = -1.33$

For z-value of 1.50: Use the row headed 1.5 and the column headed 0 to find the value 0.9332. This represents the area under the curve to the left of the critical value 1.50.

For z-value of –1.33: Use the row headed 1.3 and the column headed 3 to find the value 0.9082. This represents the area under the curve to the left of the critical value +1.33. The area to the left of –1.33 is 1 – 0.9082 = 0.0918.

The area between these critical values is 0.9332 – 0.0918 = 0.8414, or 84.14%.

Hypothesis Testing – One-Tailed Test Example

A sample of a stock's returns on 36 non-consecutive days results in a mean return of 2.0%. Assume the population standard deviation is 20.0%. Can we say with 95% confidence that the mean return is greater than 0%?

$H_0: \mu \leq 0.0\%$, $H_A: \mu > 0.0\%$. The test statistic = *z*-statistic = $\frac{\bar{x} - \mu_0}{\sigma / \sqrt{n}}$ = (2.0 – 0.0) / (20.0 / 6) = 0.60.

The significance level = 1.0 – 0.95 = 0.05, or 5%.

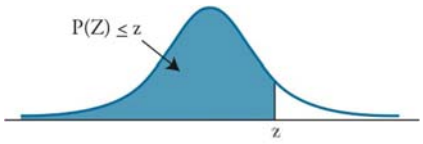
Since this is a one-tailed test with an alpha of 0.05, we need to find the value 0.95 in the cumulative *z*-table. The closest value is 0.9505, with a corresponding critical *z*-value of 1.65. Since the test statistic is less than the critical value, we fail to reject H_0.

Hypothesis Testing – Two-Tailed Test Example

Using the same assumptions as before, suppose that the analyst now wants to determine if he can say with 99% confidence that the stock's return is not equal to 0.0%.

$H_0: \mu = 0.0\%$, $H_A: \mu \neq 0.0\%$. The test statistic (*z*-value) = (2.0 – 0.0) / (20.0 / 6) = 0.60. The significance level = 1.0 – 0.99 = 0.01, or 1%.

Since this is a two-tailed test with an alpha of 0.01, there is a 0.005 rejection region in both tails. Thus, we need to find the value 0.995 (1.0 – 0.005) in the table. The closest value is 0.9951, which corresponds to a critical *z*-value of 2.58. Since the test statistic is less than the critical value, we fail to reject H_0 and conclude that the stock's return equals 0.0%.



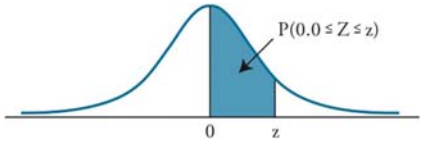
Cumulative Z-Table

$P(Z \leq z) = N(z)$ for $z \geq 0$

$P(Z \leq -z) = 1 - N(z)$

z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.937	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.983	0.9834	0.9838	0.9842	0.9846	0.985	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.989
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.994	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

Alternative *Z*-Table



$P(Z \leq z) = N(z)$ for $z \geq 0$

$P(Z \leq -z) = 1 - N(z)$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3356	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4939	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

Student's T-Distribution

Level of Significance for One-Tailed Test						
df	0.100	0.050	0.025	0.01	0.005	0.0005
Level of Significance for Two-Tailed Test						
df	0.20	0.10	0.05	0.02	0.01	0.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.599
3	1.638	2.353	3.182	4.541	5.841	12.294
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.869
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.408
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.768
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

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